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EDITORIAL

DERRIS

THE attention of readers is drawn to an article reproduced elsewhere in this number on derris or "tuba root." The writer of that article explains that the Malay word "tuba" is used for a number of poisonous plants, including various species of derris. In Malaya the two commonly cultivated species are *Derris malaccensis*, an erect, shrub-like plant and *Derris elliptica*, a creeping species forming a close cover on the ground. Notes are given on the cultivation and harvesting of derris in Malaya and on the insect pests which have been found to attack it both in the field and under storage conditions. It has been found that the toxicity of derris roots tends to vary according to their age and that the most suitable age for harvesting is when the plants are about 24 months old.

The value of derris root depends on its toxic content. There has been considerable investigation in various countries within recent years on the toxic principles of the roots with the result that four toxic compounds have been isolated, namely, rotenone, deguelin, tephrosin and toxicarol. In the United States of America rotenone is considered to be the most important of these toxic compounds and consignments of roots to that country are valued according to their rotenone content. In the United Kingdom, however, the valuation is based on the total amount of ether extract. It may be mentioned here that, according to reports received from England by this Department, the minimum amount of rotenone to be of commercial value is 5 per cent., while the usual "ether extract guarantee" is 18 per cent., with a minimum of about 15 per cent., and a sliding scale adjustment of price.

Recent investigations in Malaya have indicated that against certain insects rotenone cannot be considered a reliable indication of the toxicity, since there are other compounds which are effective and these are represented in the total ether extract. The author of the article suggests, therefore, that buyers of derris should value the root on the total ether extract rather than on rotenone content. He also indicates that *Derris elliptica* seems to be preferable for commercial cultivation, possessing as it does a rotenone content of about 7 per cent., and a total ether extract of about 25 per cent. It would therefore be suitable both for American and British markets. *Derris malaccensis*, on the other hand, with its low rotenone content of about 1 per cent., and ether extract of about 20 to 25 per cent., would probably find a sale more readily in the United Kingdom market. Recent work in Malaya has indicated that there is no difference in toxicity between these two species of derris.

On the Experiment Station, Peradeniya, small clonal plots of the above two species of derris are being cultivated in order (1) to investigate variation in ether free extract and rotenone content between clones, and (2) to provide similar material for analysis at different ages. In this connexion, it may be mentioned that in the past roots analysed at different ages have come from unrelated plants, but in future roots can be taken from plants in the same clone.

Derris is coming into general use as an insecticide, both in the powdered and liquid forms for application either as dusts or sprays. Information gained as the result of experiments against different kinds of insects is accumulating in various countries and much is being learnt as to the value of derris as a contact insecticide against certain groups of insects, its comparative ineffectiveness as a stomach poison and its usefulness in other ways. It should be noted that the Malayan Archipelago supplies practically all the tuba root of commerce and the exports have increased steadily within recent years. The author of the article concludes by saying that the future of all agricultural products is uncertain, but it would appear that the prospects of an increased demand for tuba root compare very favourably with those of other raw materials.

TOMATO CULTIVATION IN THE DRY ZONE OF CEYLON.—III

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(G) PLANTING DISTANCES

Various planting distances for tomatoes depending on the variety, soil and the methods of growing the plants have been recommended by different writers on tomato culture. Large, spreading varieties like Greater Baltimore (a U.S.A. variety) need more space than others and similarly, on the richer soils a wider planting distance is required. The method of growing the plants, *i.e.*, whether they are pruned and trained or not is of chief importance in determining the spacing to be adopted. When plants are allowed to grow unpruned and to spread over the ground they naturally require more space than those which are kept pruned and are trained to grow erect.

Even for unpruned and untrained plants there is a wide range in the recommendations made. Distances vary from as much as 8×8 ft. as reported by Pearson and Porter (1932) with some varieties grown in California to about 3×3 ft. according to Rosa (1922). Work (1926) states that spacings from 7 ft. or more to $3\frac{1}{2}$ ft. each way may be adopted in the States. The usual distance may be taken as 4×4 ft., but it is considered that even this is too high for most conditions and that profitable yields can be obtained with the closer spacings, such as $4 \times 3\frac{1}{2}$ ft. or 4×3 ft.

When plants are pruned and trained there is again much variation in the distances adopted. Under U.S.A. conditions, Lloyd and Brooks (1910) report 5×4 ft. or $4\frac{1}{2} \times 4\frac{1}{2}$ ft., Stuckey (1915) $3\frac{1}{2} \times 2$ ft. and Pearson and Porter (1932) $3 \times 1\frac{1}{2}$ ft. or $3 \times 1\frac{1}{4}$ ft. Beattie (1923) recommends $1\frac{1}{2}$ ft. each way in double rows with $3\frac{1}{2}$ ft. interspace. Holmes (1931) states that in the Canaries, tomatoes are planted $2 \times 1\frac{1}{2}$ ft. apart. In South India, Raghavan (1933) recommends 3 to $4 \times 1\frac{1}{2}$ to 2 ft. In a spacing experiment carried out in Trinidad by Paul (1934) with plants pruned to a single stem and staked it was found that with three spacings, *viz.*, 3×3 ft., 3×2 ft. and $3 \times 1\frac{1}{2}$ ft.

there was a significant increase in yield as the distances decreased. But it was apparent that the closest spacing for maximum yield under the conditions of the experiment was not reached. It is considered that in the dry zone of Ceylon a close spacing of 3 × 1 ft. may be profitably adopted.

When plants are pruned and trellised even closer spacings than those used for staking are possible such as 8 inches between plants. It is, however, desirable that when plants are pruned and trained the rows should be wide enough to permit of intercultivation operations and also to provide a sufficient passage for pickers without causing injury to the plants. For this purpose a 3 ft. wide space as a minimum should be maintained between the rows or between more closely planted double rows. In the case of trellised plants, the spacing in the A-trellis method between the plants on either side of each row of arches may be 2 ft. apart with a 3 ft. space between the rows of arches. Where the upright system of trellises is used the spacings may be 2 ft. between double rows of uprights and a 3 ft. interspace.

Under intensive methods the distances apart are considerably less than those used where the crop is grown on a large field scale. There have, however, been very few statistically valid experiments carried out anywhere to determine the optimum spacing with each method of growing tomatoes and under particular conditions of soil, climate, etc.

With closer spacings and consequent increase in the number of plants per acre the yield increases until the optimum is reached beyond which point interaction effects come into operation such as shading, root growth interference, etc., and the yields decrease. Even before this optimum is reached there is the question of the increase in the cost of production per acre owing to the larger number of plants to be grown. The cost of production, therefore, is a factor of importance in determining the closest spacing to be adopted for obtaining the maximum yield.

(H) PRUNING AND TRAINING

When tomatoes are trained it is usual to keep them in a pruned condition. Pruning consists in the removal of the lateral shoots which develop from the axils of the leaves along the main stem. This may be done by allowing only a single stem, which is the commonest method, or two or even three stems. A single stem may in turn be allowed to branch into two at the upper end of the plant.

As soon as the side shoots appear in the axils of the leaves they can easily be nipped off by hand, but if they have formed

a secondary stem they need cutting with a sharp knife. This, however, is wasteful as the plant should not expend its energy in the development of shoots which are not later needed. After 4-5 clusters of fruits have set or when the leader has reached the top of the stake to which it is tied when staking is practised, the terminal shoot may be removed. This leads to quicker and a more uniform ripening of the fruits than when a large number of clusters is allowed to develop.

Pruning has to be carried out regularly—about once a week to 10 days—depending on the growth of the plants. By pruning the fruit becomes limited to the inflorescences borne along the main stem and other stems in the multiple stem system, as also terminally on each stem. It also renders the plant more convenient for handling in training.

The tomato plant forms an erect stem until a height of 1-2 ft. is reached and it then becomes decumbent and grows along the surface of the ground. In training the plant is supported and allowed to grow upright. There are two main methods which are adopted :—(*a*) Staking and (*b*) Trellising.

In the first method, the main stem is kept erect by being tied to a stake which is placed alongside each plant. Where bamboos are available these are most suitable in split halves about 5-6 ft. long and sharpened at one end so that they may easily be driven into the ground. Stakes may also be made of stems of *Thespesia populnea* (S. Suriya, T. Puwarasu), Gliricidia or any suitably strong branches of wild trees. They should be fixed in the ground firmly about 3 inches from the base of each plant. As soon as the plants begin to need propping which is usually about 3 weeks after transplanting they are tied to their respective stakes. Each plant should be tied at its upper end to the stake with plantain fibre, hemp or soft string. As the plant grows, further tying higher up the stake is done and during the season about 3-4 tyings will be necessary. In tying, the plant should be drawn close to the stem by passing the material used for tying around the stake and then crossing it before passing it around the stem finally tying it under a leaf branch on the side of the plant opposite the stake. Care should be taken to prevent restriction of growth of the plant or the stem being cut in tying.

In trellising there are two main systems :—(*a*) Upright trellis and (*b*) A-trellis. The upright system consists of stakes about 5½ ft. high set vertically at wide intervals of about 6 to 10 ft. apart, depending on the strength of the stakes used, and a stretched wire supported overhead on these stakes. The stakes are fixed between two rows of plants spaced about 2 ft. apart so that the plants of each row on either side of the

wire are trained to grow along strings which twine around the stems of each plant and are connected to the overhead wire. The distance between each row of stakes supporting a wire should be about 3 ft. to allow for weeding and harvesting.

In a modification of this system vertical stakes are placed about 6 ft. apart and scantlings connected horizontally to these at intervals of 1, 2, 3 and 4 ft. from the ground. The trellises may be set in double rows 2 ft. apart with a 3 ft. interspace. The plants are established along one side of each row of trellises and are tied to the rails one after another as they grow up.

In the A-trellis system stakes about 5 ft. long are arched by tying each pair of arches at the top, the distance at the base of each arch being about 2 ft. The arches are connected horizontally along each row by several scantlings at intervals of 1, 2, 3 and 4 ft. from each other. The rows of arches should be about 3 ft. from each other and they should be so placed that a row of plants grows along each side of the rows of arches.

In all these systems of trellising the plants should be set quite close to each other in the row.

The subject of pruning and training has given rise to much discussion amongst growers and writers of tomato culture. In some of the northern States of U.S.A. no pruning or training is practised owing to the high cost of doing so. In other places, especially where the crop is intensively cultivated some form of pruning and training is usually adopted.

Pruning has an effect on (*a*) yield (*b*) size of fruit and (*c*) earliness of fruit. Numerous experiments have been carried out especially in the United States on the merits of pruning and while the results are somewhat conflicting—largely due to the inadequate experimental methods adopted in the past—the general view is that while pruning may reduce the total yield per plant it increases the size and flavour of the fruit as well as the yield of early fruit. The total yield per plant increases progressively with the number of stems retained but Olney (1918) found that the increase with three stems was not sufficiently marked. The single stem or two stems branched on top is most favoured for its convenience in training.

Thompson (1927) has shown that with pruned plants the root system is reduced, there are fewer roots spreading out and growing down and there is a greater loss of moisture from the soil than from unpruned plants. The last named can be overcome by closer planting of pruned plants.

When plants are pruned they are also trained and the chief advantage gained is that a greater number of plants

can be grown per acre. This fact was not realised in many of the older experiments on the advantages of pruning and training plants and in a comparison of the two systems—pruning and training with non-pruning and non-training—the optimum space for each should be used.

The general advantages and disadvantages of pruning and training may be summarised below :—

Advantages

1. The number of plants per acre is increased through the closer spacing.
2. The percentage of early fruit is increased.
3. Larger, cleaner and better quality of fruits are produced.
4. The plants and fruits are prevented from being in contact with the soil and so both foliage and fruits suffer less from diseases and pests.
5. Better facilities for cultivation, spraying and harvesting.

Disadvantages

1. The cost of production—materials and labour in pruning and training—is increased.
2. Greater susceptibility to certain diseases such as blossom end rot, sun scald and cracking around the stem, which are connected with the water deficit in the plant.
3. The total yield per plant is reduced.

There is an optimum spacing for each system of pruning and training but that optimum for yield may not necessarily be the economic optimum in view of the increasing cost of production with the increasing number of plants per acre. In general, with pruning and training about twice the number of plants per acre can be grown as compared with the ordinary method and additional expenditure is, therefore, incurred in growing, training and pruning these extra plants both in labour and materials such as stakes and string. The cost is an important consideration where labour rates are high and materials such as stakes are not easily procurable. It may be so high as to preclude the adoption of the practice in areas where also large acreages are planted. Questions of cost will determine too the particular system of pruning and training to be carried out.

In staking, each additional plant means a proportionately increased expenditure but this is not so in the case of trellising. Where, therefore, there is a scarcity of suitable rigid stakes and labour costs high some system of trellising may be adopted.

In areas where winds are strong then the upright wire trellis should not be used as the vines are not rigidly supported and are liable to sway unduly. By close planting and the establishment of wind belts this may be greatly reduced.

(I) SUPPLYING

Vacancies after planting out should be supplied on one or two occasions in large areas up to about a fortnight after planting out. It is always advisable to have a larger number of plants in the nursery than are originally required in order that supplies may be available for filling vacancies.

Care should be taken over replacing plants that have been killed by disease and particularly so in the case of soil-borne diseases.

Where plants have been killed by insect pests, such as cutworms, replanting may be done after digging up the hole thoroughly to remove any stages of the pest which may be harboured below the soil level.

Vacancies in small plots of tomatoes should be filled in as soon and as often as they arise up to about a fortnight after planting out.

(J) INTERCULTIVATION

The tomato crop needs cultivation soon after it is planted out and again as often as is necessary to keep weeds under control and the soil from hardening. Whenever available, a mulch of straw or leaves, especially towards the end of the rains should be applied between the rows of plants and, of course, after this cultivation will not be possible.

Generally about three intercultivation operations are considered sufficient during the season and should be carried out only as necessity arises. The first cultivation should be fairly deep without injuring the roots while being as close to the plants as possible. The subsequent cultivations should be further away and shallower each time until finally the surface is merely stirred. Thompson (1922) found that deep cultivation of tomato plants after they have attained a considerable size results in injury and destruction of many of the lateral roots. At the time of the second cultivation it is advisable to earth up the plants to encourage the development of more roots along the base of the stem.

When the plants are young, intercultivation can be carried out by means of a toothed cultivator worked between the rows of plants but it may be necessary to follow this up with hand-hoeing around the base of the plants. Later, hand-hoeing will have to be resorted to entirely.

Care should be taken to avoid any cultivation immediately after rain as by doing so drying of the surface would be accelerated should the rains be slight, and if they are heavy the soil would become hard when dry. Cultivation should only begin after the rains when the soil is sufficiently dry to be worked satisfactorily. When picking commences, cultivation should be discontinued.

(K) IRRIGATION

In the dry zone, yields can be very materially increased if the crop can be irrigated during that part of the season when the north-east monsoon has ceased. Again, if the crop is to be planted out at any other time of the year then irrigation is essential.

The number and frequency of irrigations will depend on the local conditions—climate, soil, etc. Heavy or frequent irrigation should be avoided, except when the crop is planted in the dry season and needs plenty of moisture in the soil, as this favours excessive vegetative growth and dropping of the early flowers. There are two periods when irrigation should not be given unless the soil be very dry :—(1) When the flowers are opening and (2) During the latter part of the ripening period of the fruit.

(L) HARVESTING

The crop is usually ready for harvesting when the plants are about $2\frac{1}{2}$-$3\frac{1}{2}$ months old or about 6-8 weeks after planting out in the field. Picking continues over a period of about 2 months. There are three stages in which picking may be carried out when the fruits have reached maturity :—(*a*) Mature green (*b*) Pink (*c*) Ripe.

Size is no criterion of maturity for once a fruit has reached the mature green stage, there is seldom any further increase in size. In the immature green stage, the fruits have a dull greenish white colour with a preponderance of white towards the blossom end. They should never be picked in this stage as they are of poor quality, showing greater acidity and they only colour after 2-3 weeks of storage and even then, never properly.

In the mature green stage there is a slight change in colour from a whitish or light green to a yellowish green at the blossom end of the fruit and the surface becomes glossy. At the calyx end of the fruit there appears a characteristic brown ring. In the pink stage, a pink colour develops from the blossom end of the fruit and spreads but not entirely over the whole surface. In the ripe stage, the fruit is still firm and has a red colour over nearly the entire surface.

The stage of maturity in which the fruits are harvested depends on the particular market for which they are grown. In the mature green stage they are picked for transport over long distances. Under favourable conditions they turn a normal red colour when ripe. In the pink stage, picking may be done for sale in local markets where the fruits will reach the consumer in 2-3 days. For canning purposes, the fruit should be ripe but not over-ripe. There is no advantage gained in leaving the fruits on the vines once they have turned a red colour.

In picking, the fruit should be grasped in the palm of the hand with the thumb pressed over the point of union of the pedicel with the peduncle and then by a quick twist the fruit is separated leaving the calyx attached to the fruit. Even in the mature green stage separation takes place readily owing to the development of a corky layer between the pedicel and peduncle.

The fruits as they are picked should be placed in a bag or basket and then conveyed to the store for grading. Great care must be taken not to bruise the fruits when they are placed in the picker's basket or transferred to the store.

Picking may be carried 3 or 4 times a week at the beginning of the season and about once a week later. Altogether about 6-8 pickings over a period of about 2 months depending on conditions may be taken, the third picking giving, in general, the best proportion of the crop.

GROWTH, POLLINATION, FRUITING AND RIPENING

Kraus and Kraybill (1918) have shown that when the tomato plant is given an abundant supply of nitrogen in the soil and other conditions are favourable for growth, it becomes vigorously vegetative ; it is high in nitrogen (N) and low in carbohydrates (C). When the plants have made good growth and the N supply is inadequate for full vegetative activity then they become fruitful. In other words, when the C/N ratio is small, vegetative activities follow but when it is relatively large, reproduction takes place. If, however, either N or C is limiting, then growth is retarded and the plants do not set fruits.

When there is rapid vegetative growth, the carbohydrates are used in the formation of new tissues in the plant and in respiration, so that the concentration of C becomes low and there is no fruiting even though there may be a large number of flowers formed. If, conditions for growth are such that it becomes somewhat checked, then the C supply accumulates and when there is a balance between certain processes of synthesis and respiration taking place in the plant fruiting

results. If, however, there is a high concentration of C_2, the blossoms may drop.

When as a result of the retardation of vegetative growth, fruiting takes place, the number of fruits that the plant can develop will depend on the amount of vegetative growth made. If the growth has been excessive or small, the setting of fruit is restricted. A moderate vegetative growth is best suited for fruiting. Removal of fruits, however, results in a renewal of vegetative growth which in turn leads to the formation of more fruits so that picking encourages fruiting.

Flowering commences about 4-5 weeks after transplanting in the field and when the plants are about 2 months old. The flowers are usually self-fertilised but in the open some cross pollination takes place. Care should therefore be taken to prevent different varieties being grown too close to each other for seed purposes.

In pollination, the style elongates during the maturation of the flower and pushes the stigma through the staminal cone. The anthers begin to dehisce about this time and the stigma in making its way through the cone becomes pollinated. In certain varieties the style elongates before dehiscence occurs and projects well beyond the staminal cone thus exposing the stigma to foreign pollen. These long styled varieties exhibit a greater percentage of cross pollination than those with short styles in which the stigmas do not project beyond the staminal cones.

During the ripening of tomatoes a supply of oxygen is essential and Sando (1920) has shown that fruits ripened in chambers or wrapped in paper developed high acidity, had a low sugar content and lacked flavour. The practice of wrapping fruits which are mature green in paper for packing is, therefore, not advisable. There are important chemical changes taking place during ripening. Sando found that until the mature green stage is reached the acidity increases but thereafter it decreases during ripening. The sugar content on the other hand increases from the time the fruit is formed until it is fully ripe while the starch content decreases. The quality of fruits which are picked in the mature green stage and ripened in storage is inferior to vine-ripened fruits. Such fruits have a lower, sugar content, a higher acidity and a slightly lower vitamin content. When picked in the pink stage the composition and flavour is almost the same as that of vine-ripened fruit.

The chief acid present in ripe fruit is malic acid which is usually about 0·5 per cent. There is also about 0·1 per cent. of citric acid. It is stated that there is also a certain amount of oxalic acid present in the tomato but there is some difference of opinion on this matter and as Bewlay (1935) states the amount present, if at all, is very small. The acid flavour of tomatoes

depends more on the H. ion concentration of the juice than on the total titratable acidity.

The colour and ripening processes are accelerated at high temperatures and in the tropics fruits cannot be kept for long in the green or ripe condition. Sando (1922) found that if tomatoes are picked just after they are mature green they could be kept for 15 days at 50° F. to 55° F. and an additional 5 days at 75·5° F. Wardlaw and McGuire (1932) report that under conditions in Trinidad mature green fruit can be held at 47·5° F. for 20 days and thereafter at 70° F. for a further 10-14 days. Under the comparatively high temperatures in the dry zone districts of Ceylon ripening of mature green fruit takes between 6-8 days.

GRADING AND PACKING

The grading of tomatoes for marketing is now practised in all tomato producing countries, but, unfortunately, the systems adopted vary with each country and there is no standard method of grading that is universal. In some countries, grading is chiefly based on quality, in others on weight and again on size. In U.S.A., the grade standards have been established by the Department of Agriculture and refer chiefly to quality while sub-grades recognised by the trade are according to the size of the fruit or the number contained in a standard package. In England, grading is according to weight and along with standard packages a national mark is issued by the Ministry of Agriculture.

A standardised system of grading tomatoes in Ceylon is very much needed. It not only helps the good grower to get a better price for the extra care required in growing and grading his crop but it also helps the consumer to buy sound fruits of uniform quality.

The first step to be taken in grading is the removal of all diseased, injured, badly cracked, over-ripe, mis-shapen and under-sized fruits as soon as the crop is brought into the store from the field. The rest should be wiped with a clean soft cloth and the calyx stem cut with a pair of scissors close to its point of union with the fruit so as to prevent bruising in packing. Care should be taken that the calyx leaves are present in each fruit as otherwise the value of the fruit is considerably diminished.

Grading is best done for size and in Florida and Bermuda mechanical graders are used. Hand grading may be done by a simple grading board in which holes are constructed to correspond to the diameters of the fruits graded according to the particular sizes selected. The sizes for the different grades can be quite arbitrarily chosen and the following are suggested:—

Grade I. Above $2\frac{3}{4}$ inches in diameter
Grade II. Between $2\frac{3}{4}$ and 2 inches in diameter
Grade III. Between 2 and $1\frac{1}{2}$ inches in diameter

All fruits below $1\frac{1}{2}$ inches should be classed as culls or ungraded fruits. At first it may be necessary to test each fruit separately with the grading board, but after a little practice the grading can be done satisfactorily without reference to the board. Fruit which is only slightly cracked or blemished may be included in the grades referred to above and all others should be strictly discarded.

Various methods of packing tomatoes are adopted in other countries, but for local markets special types of packages are not essential, although perhaps it would pay a grower to despatch his crop even to a market close by in standard packages. The important kinds of packages used are flat baskets, crates or boxes. Fruits of uniform size are arranged in these according to a definite system and the number of fruits in each package marked on the outside indicate the size of the fruits in that package. Usually two but not more than three layers of fruits are arranged in each package.

The baskets are usually made of thin fragile wood and may contain 4 or 6 small baskets within. These sub-containers reduce the pressure on the carrier basket during transit. Crates are constructed of stronger wood such as is used in the common packing case received from abroad. The ends are solid while the sides have slats separated by narrow spaces. A convenient size of crate may be 18 in. by 9 in. with the fruit arranged in two layers. The bones or the lugs are the most satisfactory packages for long distance transport and are substantially constructed. There are several types of lug boxes such as the Californian, the Columbian and Mexican. At the British West Indian fruit and vegetable conference held in Jamaica (1933) it was recommended that the British Columbian 20 lb. lug boxes should be used for shipping tomatoes from the West Indies. These have the following dimensions :— $15\frac{3}{4}$ in. by $15\frac{3}{4}$ in. by $4\frac{1}{2}$ in. The fruits are arranged in two tiers and in rows both ways with the following packs :—

Numerical count	*Arrangement*
50	5 ×5 in 2 layers
72	6 ×6 in 2 layers
98	7 ×7 in 2 layers
144	8 ×9 in 2 layers

The jumble pack contains fruit not less than $1\frac{1}{2}$ in. diameter. The Mexican lug of 30 lb. was also recommended. When fruits are wrapped they usually stand transport better but the quality is affected.

(*To be continued*)

THE PRINCIPLES OF ORCHID CULTURE IN THE TROPICS

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IN defining the principles on which orchid culture can be undertaken to afford the Orchidist the best guidance and help, it should be stated at the outset that there are no cast-iron principles or practices on which to work, as many commercial and private growers will attain the same excellent results, but under many different modes of cultivation. The reason is of course that climatic conditions guide adaptation and the plant's new environment often varies to a remarkable degree.

In Ceylon however it can be definitely stated that climatic conditions are particularly favourable for pretty well all the tropical orchids and for many of the sub-tropical orchids also. The three climatic zones of Ceylon specified as the low-country, mid-country, and up-country enable such as require hot conditions (humid or moist), intermediate conditions (humid or moist), and cool conditions, mostly moist, to be respectively well catered for.

Further, to assist successful orchid culture, there are facilities available in the direction of fairly cheap labour with little necessity for the need of any costly equipment in the way of housing structures, the materials for such structures as is required being very cheap as is the material required for potting and upkeep of the plants, and lastly there is available by import and from local sources a range of orchids suitable to any elevation or particular climatic conditions envisaged in the three zones above mentioned.

Ceylon is a small island and for its size is remarkably well opened and accessible by means of roads, major or minor, tracks and bridle paths, and offers extremely favourable facilities for the study of the natural habits of its orchids in the jungle, and of acquiring first hand knowledge of orchid physiology. It is the object therefore of this article to ascertain some general means by which orchids, and particularly exotic orchids in the tropics, can be grown to satisfaction and to

embrace the many and varied groups of orchids now in cultivation, but which only too often persistly refuse to attain this required standard. Why is it that certain orchids considered quite easy to grow in European and American countries present many difficulties under our tropical and, undoubtedly, more compatible conditions? The first, and main principle for the potential grower is that he should understand and realise the way in which orchids grow, the method by which they obtain their nourishment and the climatic conditions under which they thrive in their native habitat. He must then learn how to apply the knowledge thus gained to the many types of plants assembled from many sources and probably of very varying conditions, in a composite collection in one house or garden, in one particular locality.

ORCHID PHYSIOLOGY

Habitat. Orchids can be found in most parts of the world with the possible exception of the large deserts and polar regions. Some are terrestrial or land plants, the great majority are epiphytic and a very few are saprophytic. Of the hundreds of genera and thousands of species to be found, we in Ceylon possess 60 odd genera and about 160 species. The majority of orchids are tropic or sub-tropic, a small percentage only being temperate, and these are mostly terrestrials. The geographical distribution is remarkable as although widely distributed they are rarely found in abundance in any one place requiring as they do special or particular places and conditions. The Dendrobiums for instance are particularly eastern, numbering over 600 species with a distribution embracing Ceylon, India, Malaya, Japan, Australia and the Pacific Isles, and Vandas too are particularly eastern, whilst Cattleyas, Oncidiums and others are restricted entirely to the new world, Cattleyas to Central and South America, chiefly Brazil and in the Andean regions, Laelias to the maritime provinces of Mexico, Guatemala and Southern Brazil, and Oncidiums to Mexico, Central and Tropical America and the West Indies. The range of altitudes in which this latter genus can be found varies from the hot coastal regions to elevations of 12,000 feet in the Andes, and for that reason it is most desirable to know the mountain species which normally require much cooler conditions than the others. Since the genus Oncidium has a great number of species found in nature under such varying conditions a few further details might here be given. Careful observation of the distribution of the species will allow of quite a number being grown under much the same conditions. Some few would obviously thrive best in Colombo and similar low-country localities, others at mid-country environments like Peradeniya

and still others at the mid to up-country elevations. Taking Oncidiums as an example, *Oncidium Cavendishianum*, *O. lanceanum*, *O. luridum* and *O. papilio* would be very useful plants to grow both under Colombo and Peradeniya conditions; *O. incurrum*, *O. macranthum* and *O. Phalaenopsis* are suited to Peradeniya and the mid-country; and *O. cucullatum* to up-country elevations, as this is probably one of the coolest of the Columbian orchids.

A knowledge of the locality or the native habitat of the species is therefore something of a guide to the grower and not only the particular country or countries in which the plant is found but details of the approximate latitude and elevation, the rainfall and other climatic details of the plant's habitat have to be ascertained. With this knowledge quite a large assortment and variety of plants can be successfully catered for in the general orchid collection.

Habit.—Few growers need reminding that orchids fall into two main groups, the terrestrials or ground orchids and the epiphytes, but superficially to the beginner the groups are not always or entirely distinct in that many epiphytes can quite successfully be grown in what appear to terrestrial conditions. The terrestrials include most of the orchids found in temperate countries and many of the largest and most handsome of the tropical orchids. The lower portion of the plant in this group forms a rhizome, from the apex of which the shoot of the following season arises, or in other words each annual shoot bends upward into the leafy shoot of the current year. Being perennial, some means of food storage is required and in many cases this takes the form of a thickened internode of the stem. It will be noted that "food storage" is mentioned and it is this character that mainly, in its cultural requirements, calls for differentiation in the treatment as compared to the epiphytic group.

Nutrition.—The epiphytes are, as you know, plants that grow upon another or some elevated support. They are found mostly upon trees or on rocks and the means by which they attach themselves to such is, in the first place, by the formation of "clinging" roots which fasten the plant to its support but do not extract nourishment and which it will be noted, *grow away from the light*. The niche or niches between the plant and its support and the network of these "clinging" roots act as small reservoirs or catchment areas for fallen leaves or other decaying and humus-forming matter. Other roots, called "absorbing" roots, branch out and penetrate into this reservoir or catchment area. Finally the true aerial roots are formed and these hang down from the plant in long festoons.

It is these highly specialised roots that enable the plant to elaborate food materials from the gases and moisture of the atmosphere, and the means by which they do so is that the outer layer of cells of the aerial roots are dead and perforated, and act as a sponge to absorb water trickling over them, whilst the internal cells or tissues are green and living and they have the power of assimilating, or in other words they have the means of manufacturing from the air and from water. Most of such orchids are assisted in their quest of food by fungi, species of *Rhizoctonia*, which settle on their roots and aid them in their function of splitting air and water vapour into the requisite nutritive substances. To the initiated this illustrates the biological phenomenon of "symbiosis."

This then is, briefly, the way in which orchids grow and the method by which they obtain their nourishment and we now pass on to the climatic conditions under which the plants in their native habitat thrive.

Air.—The aerophytic character of epiphytic orchids and the mode by which these plants in general obtain atmospheric nutrition through the roots or root fungi having been touched upon, the further physiological requirements embrace the plants necessities and requirements of light, and moisture.

Light.—The influence of light on growth and activity naturally varies since some orchids are to be found only in dense shade, others in semi-shade or only mid day shade, and others fully exposed on rocks throughout the day. It varies with the particular plant and is therefore the particular plant's requirement in this respect. Taking our local orchids as an example which can be personally studied, the "Wanarajah Orchid" (*Anoectochilus regalis*) is a leafy terrestrial found only in leaf mould in the dense low-country forest, and in cultivation is most unsatisfactory if given conditions which depart very radically from these requirements. The "Daffodil Orchid" (*Ipsea speciosa*) on the other hand, a pseudobulbous terrestrial, requires a very open site and is generally found in open patna in grass in the mountain zone. Again these plants in cultivation need to be given conditions very similar to those in which they are found naturally. Of the epiphytes the dry zone *Vanda spathulata* is found on bushes and rocks in very open and exposed portions, whilst *V. Roxburghii* is most commonly found in the dry regions on tree trunks and branches subject to mid-day shade.

Taking the latter as an example, the significance of overhead shade from mid-day sun to this and many other similar species should be noted, for under normal cultural conditions other than these retard the plant's progress. Though difficult

to account for it, where light is regulated, as in a glass house in more temperate climates, it is found that with certain species, of which *Vanda Roxburghii* might be termed one, excessive light at certain stages of the plant's growth leads to upset in the working of the chlorophyll in the leaves due to over exposure. If however the plant is not exposed for too long a time the colour will return on the resumption of shade to the house. Another point of similarity is the fact that it is always advised to erect orchid houses in a way that they are open to morning sun. Why is it that morning sun is beneficial, not only to orchids but to many other types of plants ? There is a reason of course, and it chiefly concerns moisture and the right amount of moisture in the air in combination with heat, which in some way counteracts the sun's rays, thereby preventing scorching or unduly shrivelling the plant. The plants in a structure facing east receive the full sun's rays but these are tempered by a generally lower temperature resulting from the night's radiation and heavy dews. If facing a western position the plants would be exposed to the rays of the afternoon sun chiefly at a time when the temperature of the air is at its maximum and the general amount of moisture which counteract the heat rays, has evaporated and is at a minimum. A western position therefore might, and does, suit such orchids as are particularly exposed in their native habitat to hot and dry conditions throughout most of the year, but generally speaking the majority of orchids and other plants prefer the former conditions of an eastern aspect.

Moisture.—This question of moisture in the air is therefore an important one. Certain species thrive best with a low rate of humidity whilst others require a very high rate. The difference between moisture absorbed from a normally humid atmosphere and that obtained by the plant from a direct wetting by rain, or by can or syringe under cultural conditions needs careful study, for it is obvious that overwatering does occur very frequently. No hard and fast rule can be laid down with reference to watering for it requires practical experience to decide the point, in which a knowledge once again of the plants' habitat and requirements is desirable. In general however, orchids require a liberal supply of moisture whilst growing and the surroundings should always be kept in a reasonably moist condition either by regular syringing or by damping down the staging and floors. The material in which they are potted whether light, or on the heavy side has to be considered, as does the methods of potting, whether loosely or very firmly, for more frequent watering during the growing stage would be necessary where pot material is light, loose

and porous than where the compost is more heavy and is firmly packed in.

At Peradeniya, the orchid house has two wings with a glazed roof which affords protection to such plants as it is desired to rest or to protect during the worst part of the monsoon. The general principle here in watering is a simple one. Firmly potted plants such as the evergreen terrestrials are watered only when the surface of the soil becomes dry whilst the deciduous terrestrials which have a marked period of rest in which the roots are practically inactive are maintained in condition by syringing of the floor and stages during dormancy, and later when the growing stage is reached ample supplies are given by means of periodical waterings.

With epiphytic orchids a little more care is required in watering, since some of them, Dendrobiums for instance, are subject to long resting periods during which watering can be withheld and only a little syringing given, whilst with others like Aerides, on the other hand frequent watering at all periods is necessary. To the observer the reason is fairly obvious in that Dendrobiums and such like have pseudobulbs which act as a reservoir to the plant and enable it to carry on through dry spells, whilst Aerides, Vandas and their like have no such resources and must rely on daily watering for their supplies. The leathery and terete leaves of some species are an adaptation of the plants to meet dry spells by affording a reduction in transpiration and subsequent loss of moisture.

Cattleyas and Laelias in their native habitat are found in humid forests on rocks and trees mostly along the margins of rivers or ravines, and usually in shade, where they receive ample supplies of water from heavy dews and the mists that saturate the forest during the dry season. The growing season however coincides with the heavy rains and it is apparent that under cultivation these plants should never be entirely devoid of water though they too possess pseudobulbs.

A further point in regard to moisture and watering at low and mid-country elevations is that syringing of the plants during normally dry weather is best done in the morning and in the evening, with an additional syringing or damping down of benches and floors at midday, but the actual watering of the plants is best done in the late afternoon, that much at least can be generally advocated.

APPLICATION OF ORCHID PHYSIOLOGY TO ORCHID CULTURE

With regard to the application of orchid physiology to orchid culture we in Ceylon have many natural advantages,

especially bearing in mind the fact also that most tropical orchids will within reason adapt themselves to varying conditions, and the fact that the lack of any extreme range of day and night temperatures at any one place in Ceylon (if one excepts such places as Nuwara Eliya) is of great help, for orchids much dislike such variations.

Appreciating these facts, the next question is the method or form in which the different types are best cultivated. Some thrive best in pots or baskets and others on trees, but where the latter facilities are lacking pot culture is usual and is moreover often very convenient.

Pots.—There are various designs of pots and baskets available, but receptacles with perforated sides and with several drainage holes are preferred, although bamboo sections if well seasoned and of fairly large dimensions and perforated with the drainage holes as in the earthenware pot, answer the purpose equally well. Another form is afforded by cutting a longitudinal section of the bamboo joint with one side cut away slantingly, the bottom and side being well perforated and the plant fixed in with a covering of coir fibre over the potting medium and retained in position by a strand or two of copper wire.

For terrestrial orchids, pots of some kind are necessary and for certain epiphytes, *e.g.*, "Wanarajah" or any orchids which grow in marshy land or among deposits of humus, or fern roots, pots must be used. For epiphytes, the selection is a wide one since these may be grown either on suitable trees, in baskets or in pots. They really need some special provision that will admit air to circulate freely among the roots as otherwise they are liable to decay through excess of water if confined too closely. For orchids with pendulous scapes as Stanhopeas, baskets are commonly used, these being made of strips of any hard wood, usually teak, in an open crate-like arrangement.

Composts.—The potting mixture for epiphytes should consist of pieces of broken brick or such like porous material, pieces of old bark or wood, which must however be hard and seasoned and not soft and spongy, chopped up seasoned coconut husks, well leached, a small percentage of charcoal and bone chips and some sphagnum moss chopped up to some degree. This latter is not easy to obtain, being found in a limited area up-country. Growers in cooler countries make much use of peat for all orchids, but this is not obtainable in Ceylon, and a good substitute is well matured and decomposed bracken and fern roots, which are not difficult to obtain.

For terrestrial orchids a heavier compost is required and this is obtained by a mixture of good and well chopped up turfy loam, well matured leaf-mould, a small percentage of well decomposed cattle manure, broken pieces of old bark, crushed bricks, a small percentage of charcoal and a sprinkling of well steamed coarse bone meal. Though pots perforated to the extent of those used for epiphytes are not necessary, nevertheless good drainage must be given and at least two inches of good drainage material supplied at the bottom of pot, covered with a layer of sphagnum moss on which the mixture above mentioned can be placed. Certain orchids require a heavier mixture than this, for example Thunia, which thrives better with a larger percentage of turfy loam and leaf-mould with the addition of some sand.

Potting.—In all potting operations the old soil should be carefully taken from the roots, particular care being taken however not to injure or snap off any of the roots. The plant should be set fairly high, about two inches above the rim of the pot, the base of the pseudobulbs thereby being above the soil. The mixture should then be worked closely between the roots with the fingers, hard or too firm potting not being at all necessary, and the pot filled to the brim. A top dressing is generally advisable and a layer of sphagnum moss should be laid over the top and gently pressed in, and it may be necessary to stake the plant for a time until sufficient roots are formed and obtain a hold of the compost to support itself.

After potting, care should be taken not to give too much water, and after a good initial watering, spraying only will be required for sometime, but when the plants begin to make fresh roots they may be given a more plentiful supply and they should, of course, be given a shady position whilst recovering from the potting operations. In renovating by top dressing it is usually sufficient to remove the surface material, as this in course of time is apt to become sour, but one should not penetrate to any depth. Care should be taken not to injure the roots more than can be helped and the material used will of course vary according to type of plant being dressed and it should be worked in and under the roots rather than over them. This operation is best performed when new roots are apparent or new bunds are in the early stages of development. In any operation, whether potting or top dressing, the greatest care is needed to ensure that ample drainage is afforded the plant, for faulty drainage upsets all watering and spraying methods.

Propagation.—In regard to propagation there are several methods applicable to the various types of orchids. With

many ground orchids such as Arundina and Spathoglottis root division is a common method, whilst Renantheras and Vandas can be propagated by cuttings taken from the growing ends of the stems. Others such as Phalaenopsis can best be propagated from basal shoots which occur when the plants age, whilst with some species young shoots are produced at the top of the flower scape which will with care provide good material. It is wise however, as with some Dendrobiums which produce young plants on the old mature pseudobulb to apply a ball of fibre or moss to the off shoot into which the roots will attach themselves, and not to separate the off shoot until it has become well established.

Cattleyas and similar types of pseudobulbous plants are usually propagated by division of the rhizome, the latter being partially cut through at about three pseudobulbs behind the young shoot. This acts as a check to force any dormant eyes or buds behind the cut and when such are sufficiently developed the back portion can be separated and grown on as an individual plant. Propagation by seed cannot be discussed here owing to its vast scope, but though the raising of orchids from seeds has for long been shrouded in much mystery, nevertheless much information has in recent times become available and though the difficulties involved in the procedure are considerable, they are not unsurmountable even in Ceylon. The benefit or otherwise of manuring of orchids is at our present stage of orchid culture a debatable question though a weak solution of cattle manure does seem to be beneficial to many types of orchids. This however, together with hybridising and seed raising afford much future interest and scope to all concerned in orchid culture and collections, in Ceylon or elsewhere.

SUNNHEMP IN THE JAFFNA PENINSULA

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IN the Jaffna Peninsula, sunnhemp is a long established fibre crop of importance while it is also regarded as a useful green manure and fodder crop. The fibre is utilised in making the nets of the local fishermen and the crop is chiefly grown for the purposes on paddy lands following the harvest of the paddy during February and March. The pods and seeds after removal of the stems for extraction of the fibre are collected and fed to cattle. On garden lands, where tobacco, vegetables and dry grains are grown in rotation sunnhemp is only recently finding a place solely as a green manure. It is of particular value in this respect in the dry zone as it produces a large quantity of green material in a comparatively short time.

SYSTEMS OF CULTIVATION

On paddy lands as soon as possible after the harvest of the paddy crop about February or early March, sunnhemp is sown. In some areas it is cultivated under irrigation but in others it is entirely dependent on the occasional rains that fall during April or May. It is able to withstand long periods of dry weather but is nevertheless very susceptible to insect pests during such periods. Light rains during the growing season will result in rapid and vigorous growth. The crop takes about 4½ months to mature and harvesting is carried out between June and July when the pods have matured. It has been reported (1) that the best fibre is produced when the pods are fairly mature. On heavy clay or light sandy soils in the Peninsula the quality of the fibre is found to be poor and the crop is therefore not grown for fibre purposes on such soils. Moderately deep, well-drained loams have proved to be most suitable.

The seed is sown broadcast at the rate of 96 lb. per acre for fibre purposes. It is sown at this rate to allow for seed which may not germinate through lack of moisture, but on irrigated fields the rate is less. Sixty pounds per acre is regarded as about the usual quantity sown in India (1) though according to Subha Rao (2) still higher rates such as 245 lb. per acre are sown in some parts of S. India. After ploughing, the seed is sown broadcast and the land is cross-ploughed. No manure is applied but on those fields where irrigation facilities from wells are available the crop is irrigated, but as sunnhemp is a dry crop this is very light. Soils which have a greater moisture-retention capacity are not irrigated. Where irrigation is practised, furrows are constructed in the fields separating them into small plots. If there be no rain after sowing the field is irrigated along these furrows. Thereafter the number of irrigations given will depend on the rains. Generally, the crop is irrigated once in 10-15 days, but the amount given on each occasion is very small in comparison with irrigated crops, such as tobacco, chillies, kurakkan, etc., in the Peninsula. The seed germinates rapidly and in about 3 days' time it appears above ground and soon forms a thick cover.

The crop is allowed to stand until the pods formed are quite ripe. The stems are then cut close to the ground and left on the field to wither for a few days. In doing so the period of retting for extraction of fibre is reduced but this practice cannot be carried out elsewhere in the wet districts of Ceylon as the fibre deteriorates. The remaining leaves are then removed and the stems bundled and stored for further drying. They are then threshed by beating small bundles held by hand against a plank placed in a sloping position over a threshing mat and the pods separate. The dried stems are then ready for retting.

On garden lands, the crop is sown broadcast at about 112 lb. per acre during October-November. The sowing is thick in order to obtain a heavy yield of green manure and it should be completed before the heavy north-east monsoon rains in November, as too much moisture is fatal to the crop during the first fortnight after germination.

GREEN MANURING

On paddy lands, even though the crop is allowed to grow until the pods are mature and the stems are removed for extraction of fibre, the leaves and roots which are left behind are of considerable manurial value. Fields that are cultivated

with sunnhemp are not usually manured later for the next crop of paddy with compost or refuse as is customary.

In the case of garden lands, a much greater manurial value is obtained by burying the whole crop of sunnhemp when it is about 7 weeks old and the stems are sufficiently tender for quick decomposition. As the crop is usually turned in about the end of November or December during the wet season decomposition is rapid.

On garden lands in the Jaffna Peninsula, manuring is intensively practised for the tobacco crop which is usually planted about December-January, but it is also done partly to benefit the succeeding crops such as chillies, brinjals and other vegetables and dry grains in the particular rotation that is carried out in each locality. The manurial programme consists of penning live stock—cattle, goats or sheep—in the field for about three months from October and this is followed by application of cattle manure and green leaves from outside. The difficulty of growing a green manure crop and of ploughing or burying it in is due to the fact that, owing to the systems of crop rotation practised in the Peninsula by which different crops follow each other with little or no interval except during the period of penning before tobacco—considered essential for tobacco by the Jaffna farmer—,there is no suitable period in which sunnhemp can be grown and ploughed under.

At present, farmers in many areas are becoming faced with the problems of obtaining sufficient numbers of animals for penning and adequate supplies of cattle manure and green leaves. They have in some cases been more or less compelled to grow sunnhemp during October and November for green manuring purposes. In certain areas, sunnhemp is grown on some fields and is cut and removed when ready to adjoining fields for burying in where tobacco is to be planted, while in the meantime penning is carried on uninterruptedly on the latter. The view is now being held by tobacco growers that the burying of a crop of sunnhemp in the soil before planting tobacco results in an improvement in the quality of smoking tobacco. The use of too much cattle manure for smoking tobacco is undesirable, as it contains chlorine which affects the burning quality of the tobacco. Growers of better grade smoking tobacco in the Peninsula would be advised to give up penning of animals before planting their tobacco crop and grow sunnhemp during October. The crop should be ploughed in and fertilisers added. This is also considered to be a more economical method of growing smoking tobacco. Howard and Howard (3) in India reported that the effect of green

manuring with sunnhemp for tobacco was greater than heavy dressing of farmyard manure from the point of view of yield and earliness of crop.

FODDER

Sunnhemp has been found to be a useful subsidiary fodder crop in the Jaffna Peninsula. In paddy fields, after the stems are cut the pods and seeds are collected from the threshing floor and bagged. The dried leaves, husks and boiled seeds are fed to cattle. In the Peninsula fodder is a great scarcity when the north-east monsoon is over and the value of the pods and seeds, which can be stored indefinitely, is very great.

On fields where the growth has been particularly luxuriant the leafy tops can be cut and fed to cattle. Although this necessitates cutting the crop earlier the quality and yield of the fibre is not greatly affected. If the whole crop is to be grown for fodder purposes it should be cut when about 6 ft. high and the plants are about 7 weeks old. Since the green plants are not so palatable as when dry, they should be allowed to remain on the field for one to three days until somewhat dry and then stacked indoors for use as required. When mixed with paddy straw the flavour and digestibility of the latter is greatly improved.

FIBRE

The process of retting in the Peninsula is usually carried out by fishermen to whom the farmer sells, either direct or through agents, his stock of dried stems. The bundles of stems are then taken by the fishermen to the sea and after being tied at each end are weighted with stones or logs of wood close to the shore in lagoons or along a sheltered coast. But usually during the period that the stems are retted wave action is not strong. The bundles are kept submerged for a period of 5-10 days depending on the condition of the fibre, etc., but care has to be taken to prevent oversteeping which weakens the fibre, while understeeping results in very coarse fibre. If the weather is hot and sunny the period of retting is reduced and the more mature the crop the longer it takes for retting. When the retting is complete, as indicated by a certain degree of softening of the tissues, small bundles of stems are removed from the water and by grasping each bundle at one end with both hands it is beaten over the surface of the water about a dozen times and again the same number of times after holding it at the other end. Each bundle is then placed in the water again, holding it still at one end and it is then moved up and

down in quick motion so that the fibre separates from the stem. The fibre is either removed, tied at one end and allowed to dry or the bundles with the fibre still attached are left in stooks to dry. This takes about ½ a day and the fibre is then removed and dried in the sun for about 1-2 days. It is then twisted out on a spindle into a thread. Two or three threads may next be twisted into one on a spindle again and used for making stronger nets. The yield of fibre is about 400 lb. per acre, though in India the average is about 500-800 lb. per acre (1).

ECONOMICS

There is always a keen demand for sunnhemp stems as the fibre is considered by local fishermen to be superior to Indian sunnhemp fibre which is only purchased when supplies of Jaffna fibre are short. An acre of the crop is valued at between Rs. 48·00 and Rs. 72·00 depending on the growth. The fibre is rarely sold, as the fishermen extract it for their own use only but may sell whatever surplus stocks they have available. The fibre is valued at about 28 cts. per lb.

The following details are given of the cost of the cultivation and income derived from one acre of sunnhemp grown on paddy lands for fibre purposes :—

	Rs. Cts.		Rs. Cts.
Cost of seed 96 lb. at 20 cts. ..	19·20	Sale of dried stems	50·00
Ploughing twice ..	7·50	Sale of Seed 12 bush at Rs. 6·00 ..	72·00
Irrigation ..	24·00		
Harvesting ..	18·00	Sale of husks 30 bags at Re. 1·50 ..	45·00
Threshing ..	8·00		
	Rs. 76·70		Rs. 167·00

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DERRIS (TUBA ROOT)*

THE Malay word "tuba" is applied to a number of poisonous plants, amongst which various species of derris are the most important. The toxic qualities of derris have long been recognized by the Malays, who use an extract of it for fishing purposes, and by the Chinese who employ it as an insecticide.

BOTANICAL

Two species of derris are commonly cultivated in the Malay Peninsula, *Derris elliptica*, Benth. (tuba putch) and *Derris malaccensis*, Prain. (tuba merah). The former is a widely-spread plant, found from Chittagong through Siam, Cambodia and Malaya to New Guinea and the Bismarck Archipelago. It is doubtful whether it is ever found truly wild in the Malay Peninsula.

Derris malaccensis is indigenous to Malaya. Most, if not all of the local stock of *D. malaccensis* originated in Sarawak, hence its varietal names—*sarawakensis* and "Sarawak erect."

Derris malaccensis var. *sarawakensis* is an erect shrub-like plant, the stems not trailing on the ground, or forming a cover. It is widely known under the names "tuba rabut" and "Sarawak erect."

Derris elliptica, "Sarawak creeping," an introduction from Sarawak, has a prostrate habit, forming a close cover, with the stems often rooting profusely between nodes.

Other varieties of *Derris elliptica* have been described and are of importance in view of the fact that the toxic content of the varieties varies considerably. Intending planters are advised, therefore, to give very close consideration to this point before embarking on the cultivation of this crop, in order to make sure that the stock is the best obtainable.

CULTIVATION

Derris is propagated readily by means of stem cuttings. The cuttings are mature wood and about 18 inches in length. They are planted thickly in nursery beds and kept in a moist condition. The nursery is preferably sited in a damp ravine adjoining the land it is proposed to plant. A layer of *lalang* grass is laid over the cuttings to conserve moisture, and watering is undertaken as may be found necessary. By this means the cuttings root in three weeks and when transplanted, at about six weeks, form a comparatively regular stand. If the cuttings are planted direct into the field, it is advisable to remove the leaves to prevent the stems from drying from excessive transpiration. It is generally found that if the cuttings are planted without the use of a nursery, a number die; they should be replaced as early as possible by fresh cuttings so that an even stand is eventually obtained.

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The cuttings are planted in a slanting direction, with about two-thirds of the length of the stem below the surface.

The method adopted by Chinese market gardeners is to plant long cuttings, twisted into a circle, at distances of about 6 feet apart and to allow the plants to ramble over the ground. During growth, pig manure is applied to the soil. The crop is not harvested at one time, but roots are lifted as required.

Derris should be planted in a light soil of a sandy nature. Heavy clay soils are not recommended, owing to the difficulty experienced in harvesting the roots under such conditions. The land should be flat or gently undulating; steeply sloping land should not be selected owing to the extreme danger of soil erosion.

When the cuttings have rooted in the nursery bed they are planted out in ridges at a distance of 3 feet apart, giving 4,840 plants per acre. The soil should receive a preliminary cultivation and be worked up into a fine tilth during the operation of ridging.

Derris is frequently planted as a catch crop with such permanent forms of cultivation as rubber and oil palm. In view of the increasing importance of the root as an insecticide, it is probable that it will be more seriously considered as a sole crop, or as a rotation crop.

HARVESTING

The toxicity of derris roots varies according to their age; it is most important, therefore, that harvesting should take place at the correct stage of maturity. Experiments have shewn that, taking into account both the yield of root and the toxicity, the optimum age for harvesting is when the plant is about 24 months old.

At the time of harvesting, the stems are cut and drawn on one side. Neither the stems nor leaves have any toxic value. The entire roots are then lifted, cleaned of soil and tied into bundles. It is important to harvest the smaller roots as the percentage of toxic principle contained in them is higher than that of the larger roots. The thickness of the roots should not greatly exceed that of a pencil.

The roots are sun-dried and baled. Sun-drying may take from 7 to 15 days, according to season. Where derris is produced on a large scale, a special flue-heated drying chamber is employed, in which the roots, after being chopped into 5 to 6 inch lengths, are dried at a temperature of 130° F. in about three-and-a-half days. The bale measures approximately 42 inches by 30 inches by 28 inches and contains about 250 lb. of dried root. It is essential to bale the root immediately after drying otherwise it is liable to attacks of boring beetles.

The yield of air-dried roots is approximately 45 per cent. of the weight of fresh root. The moisture content of the air-dried product is about 10 per cent. Under suitable conditions, the yield of air-dried root is about 1,000 to 1,200 lb. per acre.

PESTS AND DISEASES

Derris is subject to considerable injury by numerous insects both in the field and in storage. The most serious of the field pests is a Chrysomelid beetle, *Craniotectus corbetti* Laboiss., which attacks the leaves. The beetle readily

succumbs to a spray consisting of pyrethum powder 1·67 lb., soap 1·67 lb., petroleum 0·8 gallons and water 40 gallons. The total cost of application including material and wages, amounts to $1·70 to $2·00 per acre. The spray would be reduced in cost and would probably prove equally satisfactory if petroleum were omitted.

Dried derris is liable to damage by several species of beetles in both the larval and adult stages. The adult beetles will attack the root a few days after harvesting, but prefer the very dry rot. They lay their eggs in cracks and irregularities on the outside of the root, and the larvae, on hatching, bore into the root and reduce it to powder.

Infestation is not always apparent as it is only the adults which eject frass from their tunnels ; it is therefore necessary to take samples of root and split them to ascertain whether beetle larvae or adults are present.

Unless the store is provided with windows covered with wire gauze of 1 mm. mesh, and with doors that fit perfectly, the protection of the crop against infestation by beetles is almost impossible.

Complete elimination of infestation can be secured if the root is ground to powder and packed in tins. Another method is to cut the dried root into pieces of about 2 inches in length which are then packed in plywood chests. A chest measuring 19×19×24 inches will hold about 100 lb. of dried root. If this method is used packing must be carried out expeditiously after drying.

The beetles and larvae are destroyed if the infested roots are exposed to bright sunlight for about five hours.

Fumigation with carbon bisulphide is also recommended. The roots must be treated in a room which is sufficiently air-tight to ensure the minimum escape of vapour, and fumigation extended for a period of 72 hours. The quantity of carbon bisulphide necessary will be 2 to 3 pounds per 1,000 cubic feet.

Subjecting infested root to heat for three days is also a satisfactory method of destroying the borers, and, if the crop is being grown on a rubber plantation, it will be found convenient to use the smoke-house for this purpose.

From the above account, it will be realised that the aim must be to obtain an insect-free product, and to attain this object the efficient storage of the root to prevent the beetles from gaining access is of first importance.

No serious fungus diseases have been recorded.

COST OF PRODUCTION

It is estimated that under favourable conditions, the total cost of production of dried derris may be from 18 to 20 cents per lb., of which 10 cents represents the cost of harvesting, drying and packing and 8 to 10 cents planting and cultivation.

TOXICITY

The utility of derris root depends on its toxic content. Knowledge of the toxic principles of the root is as yet incomplete, but considerable advances in this direction have been made in recent years, and four toxic compounds have been isolated, *viz.*, rotenone, deguelin, tephrosin and toxicarol.

It was thought at one time that rotenone was by far the most important of these compounds, and this opinion appears still to be largely held in the United States of America, for which reason consignments of roots to that country are valued on their rotenone content. On the other hand, valuation based on total amount of ether extract is employed by importers in the United Kingdom.

Recent investigations in the Department of Agriculture indicate that against certain insects, rotenone is not a reliable index of the toxicity, there being other compounds in the roots which are effective and which are represented in the total ether extract. The opinion is advanced, therefore, that buyers of derris would be well advised to value the root on the total ether extract rather than on rotenone content.

Derris elliptica appears to offer the best possibilities for commercial cultivation, since buyers who insist on rotenone favour this species as the rotenone content is about 7 per cent., while the total ether extract is about 25 per cent.

The roots of *Derris malaccensis* give a high ether extract, but a low rotenone content. The amount of crude rotenone in roots of this species is about 1 per cent., although the ether extract is usually about 20 to 25 per cent., and therefore suitable for sale on the United Kingdom market.

USES

The principal use of derris is as an insecticide. It is one of the essential ingredients of several proprietary insecticides used as dusts and sprays.

To prepare an extract of the root for use on a small scale, the Chinese and Malays pound the root to a pulp under water, using about 1 lb. to 18 gallons of water. The resultant milky liquid is then sprayed on the plants. It has been stated that the toxicity of this liquid decreases on keeping, but recent experiments conducted by the Department of Agriculture do not confirm this statement. Derris may also be applied in a finely divided condition, known as a dust, and it is in this form that it is frequently presented for commercial application.

Derris is an efficient contact insecticide against certain classes of insect, but it appears to be less effective as a stomach poison. The indications are that it acts as a repellent to certain insects, the nervous system probably being affected through the integument. It also appears to be toxic to insects without actual contact, indicating that it yields a volatile poisonous substance.

The literature on derris is a growing one; information concerning its effectiveness by various methods of extraction and application and against a wide range of insect pests is at present scattered through many scientific publications. The results of experiments in various parts of the world are leading to more precise information, pointing not only to its extended use and to better methods of application, but also to its limitations. It is not claimed for derris that it is effective against all insects, but knowledge of the species of insects against which it is effective is rapidly increasing.

Amongst uses to which derris has been put may be mentioned the following :— An aqueous solution of rotenone has been found to be effective against thrips, white fly larvae, leaf-hoppers, larvae of beetles, and tent caterpillars. The dust form, with a carrier of diatomaceous earth intimately mixed with precipitated rotenone has been successfully employed against chicken lice, roaches and cabbage worms. Injury to peaches and apples by *Popillia japonica* Newn. was considerably reduced by derris root spray applied weekly, and a derris-soap wash consisting of derris powder 1 lb., soft soap ¼ lb., water 1 gallon, has been used with considerable success in England against the warble fly pest of cattle.

MARKETING AND TRADE

Practically all the tuba root of commerce is derived from the Malayan Archipelago. The area in Malaya is estimated to be 3,500 acres, of which 1,075 acres are planted as a sole crop, the remainder being interplanted with more permanent forms of cultivation.

The exports have steadily increased during the past three years. Total exports in 1931 were 98 tons, valued at $53,633 ; in 1932 they were 210 tons valued at $92,334; and in 1933 they amounted to 642 tons, valued at $282,795.

Greater knowledge of the use of derris and also of its limitations as an insecticide are in a large measure responsible for this increase in demand, but the increased sales are also due to improved methods of packing and to an improvement in the product itself. The cultivation by responsible persons had also given greater confidence in its value. There is less likelihood of adulteration than formerly and greater effort is made to cultivate varieties with a high toxic content in view of the fact that sales are now generally based on chemical analysis.

At the time of writing the Singapore price of roots sold on ether extract basis is $42 per picul, and roots sold on rotenone content $53 per picul (These prices are equal to 31½ cents and 40 cents per lb. respectively). At these prices derris cultivation shows a profit. The future of the market for all agricultural products is uncertain, but it would appear that the prospects of an increased demand for tuba root compare very favourably with those of other raw materials.

THE USES OF COTTON SEED*

MUCH has been written in recent years about the close connection between the price of cotton and the tendency of the growers throughout the world, especially in America, to reduce or increase the area under cotton according to the actual cash return they receive for the crop. In such calculations, however, it must be remembered that the price received for the cotton seed is also a factor in the economic yield of the crop, and sometimes a more important factor than is generally realized. In America a waggon load of 1,500 lb. of seed cotton produces approximately a 500-lb. bale of cotton lint and 1,000 lb. of cotton seed, but it will be seen from the following table that the proportions of the total cash return to the planter which come from the lint and the seed respectively have, to take only recent years, varied very greatly.

TABLE I

ESTIMATED PRICES RECEIVED BY GROWERS FOR COTTON LINT AND SEED

	Prices		Total Prices Received. (Based on a yield of 200 lb. of lint per acre and 400 lb. of seed)			
	Cotton (Cts. per lb.)	Seed ($ per ton)	Cotton ($)	Seed ($)	Total ($)	Seed per cent. of total
May 15, 1930 ..	14·5	30·61	29·00	6·12	35·12	17·4
Do 1931 ..	8·8	22·32	17·60	4·46	22·06	20·2
Do 1932 ..	5·2	9·66	10·40	1·93	12·33	15·7
Do 1933 ..	8·2	12·00	16·40	2·40	18·80	12·8
Do 1934 ..	11·0	22·23	22·00	4·45	26·45	16·8
Do 1935 ..	12·0	39·36	24·00	7·87	31·87	24·7

Thus in the 1934-35 season the drought in America produced a great shortage, not only in the cotton crop, but also in the supply of hogs (depending on the corn crop, which suffered even worse than cotton) and therefore of lard as well as in other vegetable oil seeds, with the result that the price of cotton seed shot up to levels that have not been seen for many years.

The reason why the prices of cotton and cotton seed move almost entirely independently of each other lies in the fact that the uses of cotton seed bring it into a world market in which cotton seed plays a relatively small part, and its price therefore affected largely by the supply of all the other commodities

*By John A. Todd, M.A., B.L. in *The Empire Cotton Growing Review*, Vol. XII, No. 4, October, 1935.

which enter into that market. It should therefore be of interest to cotton growers to have some idea of what these other commodities are and how they compete with cotton seed.

The development of the cottonseed trade, with the extraordinary variety of uses to which is now put, is one of the romances of modern industry. At first the seed was regarded in many countries almost as a nuisance which cost money to get rid of, unless it could be used as manure or sometimes as fuel. Before the War it had become one of the stock illustrations of the utilization of by-products ; now it is an industry in itself, with a turnover worth probably £50,000,000* per annum, and its products are the raw material of a hundred trades, from cattle-rearing to soap-making, edible oils and artificial silk.

The general outline of the processes of manufacture must first be described. Its nature depends in the first place on the character of the seed. American Upland seed and other similar varieties are what are known as "white" or "fuzzy," owing to the short lint or fuzz which with the whole seed is coated, and which is not removed by the process of ginning. Egyptian and Sea Island seeds, on the other hand, are "black" or "clean" seeds, having no short lint or fuzz except occasionally a small tuft of short green lint on the pointed end of the seed. In America, therefore, it has always been customary to put the seed through what practically amounts to a second ginning process called "delinting" and the short lint thus obtained is what is known as "linters." These used to be regarded as of comparatively small commercial value, being fit only for such purposes as gun-cotton or blotting-paper, or for mixing with waste cotton in spinning low-count yarns ; but they constitute quite a considerable proportion of the American crop—say 1,000,000 bales—and it is a curious fact that the amount of linters crop does not vary in proportion to the lint crop. On the average of the last ten years, however, the linters crop was about 7½ per cent. of the whole crop. A similar process has for many years been applied to Indian cotton seed or Bombay seed, as it is generally called in European markets, as well as to Chinese, Russian, Brazilian and African cotton seed. Even after delinting, however, the greater part of the short fuzz still remains on the seed. Since the War an important new use for linters has been as the raw material of artificial silk, though this use has not yet been fully developed in England owing to the high cost of securing the necessary cleanliness or cellulose purity of the product. The best linters are now worth rather more than half the price of American Middling cotton, but lower grades go to much lower prices.

The next process in the case of American seed is decortication, which consists practically of cutting or cracking the seed so as to separate the kernel from the husk, with the fuzz which still adheres to it. In Egypt and in Europe (except where seeds of the Americantype are handled) the whole seed is crushed without separating husk and kernel, and Bombay seed is treated in the same way as Egyptian. In China, where cottonseed crushing began only about

*The world's cotton crops now amount to about 25 million bales of 500 lb. Every bale of cotton lint represents roughly 1,000 lb. of seed, so that the total cottonseed crop must be about 12 million tons, with an average value of, say, £4 per ton. The value of the finished products is of course much larger.

1910, the American methods are followed, and the same applies generally to the Russian crop, most of which is now of the American type of seed.

The meal or crushed kernel, or the whole seed crushed, as the case may be, is then heated by steam in an enormous kettle, after which it is put into bags or wrapped in clothes in an oblong shape ; it is then pressed in hydraulic presses of great power, thus extracting the oil and at the same time giving to the remainder the peculiar form in which it is so well known as cake for cattle-feeding purposes. There is now an alternative method, known as the Expeller process, of extracting the oil from the crushed seed by forcing it through a tapered cylinder by the action of a heavy rotating screw. In this machine the residue or cake is thrown out in a broken condition, and is known as expeller cake.

The crude oil from the presses is refined by various processes, chiefly based on the use of caustic soda, and is used either as edible oil or for soap-making, according to its quality. In the case of Egyptian oils made from undecorticated seed, a small quantity of dark resinous matter exudes from the husk in the crushing process, which darkens the colour of the oil and gives it a peculiar flavour. To remedy this it is necessary to use stronger chemicals in refining the oil, but until the discovery of the deodorization process about 1910 it was never possible to eliminate the peculiar flavour entirely, and this seriously handicapped the use of these oils for edible purposes.

The black grease or refuse of the oil-refining process goes through various further processes, by which still other by-products, such as glycerine and white candle grease, are taken from it. The residue is at last reduced to the consistency of pitch, and in this form it is spread upon brown paper with a thin layer of coarse cotton fibre on its surface, thus forming the familiar, waterproofed wrapping paper in which many forms of textile and other goods are packed, especially for export. This pitch is now also used for insulating covered electric wires. There is also another refining process by which a cheap form of soap (useful for textile purposes) is produced directly.

In view of the predominance of the American crop in the world's cotton supply, American cottonseed still supplies the bulk of the cottonseed oil trade. It is chiefly manufactured in the United States, and is largely consumed in that country, as well as being exported to all parts of the world in normal seasons. A considerable quantity of cottonseed meal is also exported, but the cake is mostly consumed in the United States. The Egyptian crop is partly crushed in Egypt, though the greater proportion of it is exported in the form of seed to European ports. Some of the Bombay crop is also exported chiefly to the United Kingdom. France and Germany used to take a considerable share of the Egyptian crop, but since the War England has taken the lion's share, and since 1931 the Continent's share has been very small.

The English cottonseed industry is centred in Hull, Liverpool and London, with a considerable trade also in Glasgow, Leith and Bristol. It used to be confined practically to Egyptian and Bombay seed, Egyptian being more than half of the total, but in recent years increasing quantities of Empire seed from East and West Africa and also of Brazilian white seed have been coming to the United Kingdom. Egyptian black seed, however, still forms the bulk of the U.K. trade. The finished products must, of course, face the competition of those of the American industry.

In discussing the relative value of different oil seeds it is necessary to keep in view the two main products of the seed—namely, oil and cake. Thus, as regards the quality of the oil produced, the American method was superior for the production of high-class oils ; the removal of the husk or shell by decortication and the use of the crushed kernels alone for the production of oil produced a finer quality of oil than could be obtained by crushing the whole seed. Accordingly, the standard grade of American sweet oil, known as "Prime Summer Yellow," used to represent the highest quality among the world's cottonseed oils, while the Egyptian came next and Bombay last. The application of the American method of decortication to other varieties of white seed in England has, however, produced oils quite equal to the American.

The market for cottonseed oil is highly complex or composite, alike from the side of supply and of demand. Cottonseed oil enters into two formerly distinct markets which may be generalized as edible oils and soap fats, and in each of these fields it had competitors innumerable. Thus, as edible oil, it had to find its place in a long list containing all the animal fats, lard and even butter itself, as well as all the other edible vegetable oils, especially olive oil. In this branch of the market American cottonseed oil, until before the War, stood almost alone. Egyptian oil, owing to the peculiar flavour above referred to, was so far behind the American as to be hardly a competitor at all, while Bombay cottonseed oil was not regarded as possible for edible purposes. Bombay oil, along with a number of other vegetable oils such as those obtained from linseed, maize, soya beans, rubber seed, copra, coconut, palm oil, sunflower and many others, the very names of which are hardly known to the average layman, had their places at various points in the supply of vegetable oils ; they were mainly used in the soap and candle trades and other manufactures, where also until then Egyptian cottonseed oil found its chief demand. In this trade the vegetable oils had to compete with tallow, whale oil, and other low-grade animal fats, the better qualities of which came into the more profitable market for edible products. Linseed oil had, of course, its own special market for paint mixing, and in this it had practically no competitor, though latterly soya bean oil had been tried for this purpose with some success. Mineral oils such as petroleum are, of course, an entirely separate branch of the oil trade.

Conditions, however, have altered very materially since about 1910 in all trades into which cottonseed oil enters, and the relative position of the different products has been entirely changed. It is impossible to enter into these changes here in detail, but on the whole they have been in the direction of improved methods of dealing with what were formerly the lower-grade oils from the edible point of view, such as Egyptian and Bombay. In 1910, owing to the failure of the usual supply of edible oils and fats, such as olive oil, American cotton seed and American hog lard, a great deal of attention was devoted to discovering improved methods of handling these crops, especially the Egyptian, so as to improve the quality of the product from the edible point of view. It must be remembered that the chief use of oil for culinary purposes in England is not as oil—butter, the most expensive form of animal fat, has always taken in England the place filled by oil in Europe—but in some

composite or made-up form, such as lard, margarine, etc. Until 1910 the makers of these goods preferred either animal fats or the finer American sweet oil. But in 1909 there was an extraordinary combination of disastrous shortages in almost every branch of the supply of edible oils and fats, with the result that the consumers were forced to turn their attention to other sources of supply, and particularly to Egyptian oil. The result was a marked change in the position of cottonseed oil in the English markets. It was no longer merely a soap fat, but also an edible oil (as it had always been in Egypt) and therefore able to command a higher price, which was still further augmented by the general high level of prices of all edible oils. In 1911, however, the enormous American crop entirely reversed the conditions, and the value of Egyptian oil returned to something like its former relative position, while the lower price of American oil again made it available for soap-making.

In the same way, but to a more marked degree, Bombay oil had before the War been looked upon in England as quite impossible for edible purposes, but in modern industry it is not safe to say that anything is impossible, and by about 1910 oil refiners had succeeded in producing quite satisfactory edible oils from Bombay seed.

Many other oils have passed through a similar phase. Thus, copra and palmkernel oil were found adaptable (under pressure of unusual demand) for certain edible purposes, especially margarine, and even soya bean oil, which at first was classed as only fit for soap-making, soon proved a useful substitute for linseed oil, and was then, by still further refining, made into good salad oil.

Again, about 1912 a new process of deodorizing oils produced almost a revolution in the supply both of soap fats and edible oils. This process, first introduced in America, consisted in blowing super-heated steam through the oil, thus removing all objectionable flavours and making it possible to extend enormously the possible sources of supply of edible oil.

Again, a new hardening process was still more of a revolution. The original patent was taken out early in the century, but it was not until about 1911 that it became possible to apply the new method commercially. Broadly, the whole group of oils or fats used to be divided into two sections—soft or liquid oils, and hard or solid oils. Linseed, cotton, rape, whale oil, etc., belonged to the first group; coconut and palm oil, etc., to the second group. There was formerly a difference of nearly £10 per ton between the soft oils and the hard oils in favour of the latter, owing to the fact that a certain proportion of hard oil had to be used in the manufacture of margarine and soap in order to produce a firm product. The new invention was based on the discovery that by the removal of certain constituents soft oils could be converted into a hard stearine. Thus, linseed oil, whale oil and cottonseed oil, when treated by this new process, became harder and more solid than even tallow. The cost of the process is now about £5 per ton. The result was to draw the two groups closer together in value, because of the readiness with which the one could now be substituted for the other. The effect of such a revolution as this was not to increase the available quantity of fats and oils for the world's consumption, but rather to change the course of markets from one industry

to another. As far as cottonseed oil is concerned, the result was that the whole output became available for edible purposes in the form of hard fat, but a further supply of that or some other material was needed to meet the requirements of the soap trade.

Another important development in the last ten years is the large increase in the world's production of whale oil, which in one year (1931) reached the enormous total of 3,689,631 barrels (of which six go to a ton) as against about 750,000 barrels before the War. This was, of course, entirely excluded from use as edible oil until the development of the new processes above referred to, but these have completely altered its position. The fact is that the distinctions between edible oils and soap fats and between soft oils and hard fats now hardly exist, and almost any oil or fat can be made available for almost any purpose.

Table II. summarizes the world's production of the various oils, animal and vegetable, and indicates the relative importance of each source.

TABLE II

WORLD'S PRODUCTION OF VEGETABLE OILS AND FATS

(From Messrs Frank Fehr and Company's Annual Review)

	1929	1930	1931	1932	1933	1934
	Tons	Tons	Tons	Tons	Tons	Tons
Olive Oil ..	1,007,000	500,000	739,000	810,000	751,000	813,000
Coconut Oil ..	925,561	827,749	757,744	696,035	793,650	805,169
Cottonseed Oil	802,466	767,320	775,242	822,643	767,638	748,257
Groundnut Oil	698,802	697,888	708,339	480,134	576,860	601,004
Linseed Oil ..	686,719	570,805	629,885	628,083	533,793	492,271
Soya Oil	365,924	320,519	327,556	370,131	344,252	350,888
Sunflower Oil ..	250,957	301,419	303,228	255,400	279,962	230,117
Palm Oil ..	230,933	273,746	252,204	272,290	330,949	348,000
Palmkernel Oil	211,638	211,229	190,645	228,296	185,682	203,560
Castor Oil ..	65,076	54,320	54,352	45,591	51,206	47,407
Wood Oil ..	63,000	70,000	50,000	47,220	72,611	65,000
Rapeseed Oil ..	52,395	34,872	31,923	49,265	34,287	22,445
Sesame Oil ..	40,188	46,800	27,224	21,020	21,976	16,517
Margarine* ..	1,312,500	1,148,000	1,087,658	1,010,567	910,138	893,366
Butter ..	1,291,887	1,315,000	1,761,000	1,518,950	1,615,062	1,583,300
Lard ..	799,730	689,805	693,758	702,437	792,230	681,875
Tallow ..	290,965	284,452	321,629	315,284	362,011	332,032
	7,783,241	6,965,924	7,668,729	7,262,779	7,513,169	7,340,842
Whale Oil ..	310,312	466,755	615,700	149,458	425,067	413,058

*Not included in total as it is the product of other oils.

A word may be added as to the relative values of other varieties of cotton seed, especially Empire, compared with American. It is difficult to get comparable figures because no quotations are available in England of American cotton seed: but against the recent price of about $40 per ton in America the following quotations of different varieties in this country may be noted: Egyptian (black) about £6 5s. per ton and "White sorts" about £4 to £4 5s. But the real difficulty is in comparing the prices actually received by the growers, for this involves not merely the prices of the different kinds of seed when they reach a world market, but the cost of getting the seed from the grower to that market, and of course, with a commodity like cotton seed, of which the bulk is very great in proportion to its value, this cost is extremely high. In Uganda, for example, cotton seed was almost unsaleable in 1933-34 because the cost of the long railway haul to the port and thence by sea to England was almost more than the very low price which such seed was fetching in England at that time. In 1934-35, however, owing to the scarcity above referred to and the better prices obtainable for all classes of seed, the growers were able to secure a price of about 25s. per ton. That, of course, compares very badly with the $40 paid to the grower in America, but the difference is largely due to the fact that in the American Cotton Belt the market for the seed is at the growers' very door, for seed-crushing plants are scattered all over the Belt. The difficulties of setting up similar plants in the comparatively small areas of the Empire cotton fields are almost insuperable.

FOOD, FARMER AND FUTURE*

"CONSIDERING *Punch* as the expression of the popular voice . . . is it not also surely some over-ruling power in the nature of things, quite other than the desire of his readers, which compels him, when the squire, the colonel and the admiral are to be at once expressed, together with all that they legislate or fight for, in the symbolic figure of the nation, to represent the incarnate John Bull always as a farmer —never as a manufacturer or shopkeeper and to conceive and exhibit him rather as paymaster for the faults of his neighbours, than as watching for opportunity to gain out of their follies."—John Ruskin. Lecture at Oxford. Nov. 1883 (Cook and Wedderburn ed. Vol. 33, p. 365).

Signs are everywhere to-day that the desire is growing in us to put the house social more under considered control : we see that the happy-go-lucky individualism of the past must give way to a well-thought-out system, which will be to the greater good of a greater number ; we see the need to infuse a greater share of human sympathy into commerce and industry, in place of the unbridled spirit of competition that has too long prevailed : in other words, there is an obvious desire to introduce scientific practice into our affairs, so that we may work with calculated effect.

Life is so complex that we have forgotten how entirely food is its foundation and mainstay. We have taken what is provided as a matter of course, with little thought for the stomach : too easily assuming that nothing unwholesome would be offered, scant allowance has been made for commercial greed. The use of crude fuels, such as coal and oil, has led us to overlook our own need of carefully chosen fuels of altogether special quality : in fact, twenty years ago, when the War began, we had but a few rough rules to guide us. The rapidly growing science of dietetics has been developed almost entirely since the War. We now know that Nature exerts her control by homoeopathic means : that our gross foods are assimilated under the influence of indispensable very small proportions of a large number of accessory agents, in balance, each of which apparently serves the special ends of some one or other of the many separate, departmental activities of the human system. A trace of iodine may shift the balance from idiocy to sanity. No factory is in any way an approach to our bodies in complexity and perfection of organi-

* By Henry E. Armstrong in *Nature*, No. 3441, Vol. 136, October 12, 1935.

sation. Not a few of us look forward with comfortable assurance to a time when present-day curative medicine will give way to a preventive medicine which will all but insure health, through proper feeding. An Erewhonian situation will then prevail: disease will be punishable—because it will be admitted that it is mainly due to misfeeding and malnutrition.

Once established, this attitude towards health must affect our policy in every direction. In asking for a national stock-taking, Mr. Lloyd George has shown that he already has a dim notion of the coming state of affairs when official ignorance will be overcome by constructive knowledge, broadly spread throughout the community, not localised in a bureaucratic service. We have to define an agricultural policy without further delay.

Milk will be our mainstay and primary care, being Nature's ideal food, the food of infancy. As a nation, we have yet to recognise the general value of milk; that the Milk Marketing Board should feel called upon to press it upon the attention of the medical profession, by a weekly advertisement in the *Lancet*, is not merely farcical but little short of a tragedy. We have to create a milk conscience in all concerned with its production. Proper conditions of cow-keeping must be enforced, throughout the country; we must not allow the trade to be in ignorant hands. If rigid count can be kept of publicans, control of dairymen should not be impossible. Maybe, if it were taxed, as dear as beer, milk would be more valued and more popular. Everything has yet to be learnt about milk. Certain deficiencies are to be recognised even in the best product. Whether these are innate or the consequence of long continued malnutrition, due to exhaustion of our soils, is a question.

If cows came "from out the East," originally they will have been exposed to a fuller measure of sunlight than are our cows to-day; if so, their output of the much belauded D advitant may have been greater, particularly if better feeding put more ergot-sterol into the hides of the Eden herd. Eve, noticing that the animals generally ate it, may have been led to give a bite of grass or of some water weed to her infants with her milk; civilisation has made modern mothers less considerate, though I hear of my Californian great-grandson being given spinach from early infancy. In fact, we do not yet know what milk is, might be or should be. A vast field of scientifically directed, experimental inquiry lies open—real inquiry, not randomised research.

The inquiry into milk will involve no mere study of milk but also of the animals producing it and of the foods from which it is made. We may say already, that we know—some few of us feel it in our bones—that, like ourselves, when properly fed, cattle will be free from disease. Grass hitherto has scarcely been a cultivated crop—we have to study its cultivation, under

the various conditions of soil and climate which prevail in our islands ; this applies equally to other crops used in feeding farm animals. Milk will surely be found to vary in quality—eventually the districts producing it will be graded and specially named, as vineyards are in France and Germany : *Lieb-fraumilch* will not be the only brand : *Milch, Weib und Gesang* will be our modern *Sprichwort*. Our Wine and Food Society will have its milk tasters who will vie with Mr. Andre Simon as a wine taster ; A Marcel Boulestin-Ambrose Heath combine will act as grass tasters to cow herds, as well as in testing our salads.

A problem to be inquired into is the cyclic variation with the year in grass and other green foods supplied to cattle. The plant must change its character in passing up to the climax of its growth and thence down to maturity. Milk must be correspondingly affected. At present, all that we know is, that some of the shortcomings in winter food may be met by rationing cattle with summer-grown grass, cut young and immediately dried with special care. In an experiment which I was instrumental in starting at Christ's Hospital, three winters ago, six cows out of a herd of thirty-six were fed with such grass, grown, cut and dried under the superintendence of Sir Frederick Keeble, at the Jealotts' Hill Farm of Imperial Chemical Industries, Ltd. Throughout the winter, the six remained sleek and gave a milk of summer character, whilst the rest of the herd fell off as usual, giving an ordinary poor winter milk. Similar results have since been obtained elsewhere. We may hope that, some day, winter conditions may be overcome by justifying the practice of the Laputan philosophers.

To produce grass of the right quality, the growing plant must be sprayed with water and even with fertilising solutions, at the expedient moment. The supply of water therefore, must be taken into account and due provision made. Ultimately, it will be found that only certain districts are suitable for the production of a standard article—these will be definitely earmarked for the purpose and supply regulated to meet the demand.

In connexion with milk, butter and cheese will need special consideration —to what extent we are to supply ourselves with these. We are so ill-supplied now that the public is losing all sense of quality in cheese—the gullible house-wife will take anything, provided it be in wedges wrapped in tin-foil, paying through the nose for it. Each country should have a cream cheese of note : dairymaids generally should be called upon to show that they have the imagination to produce distinctive articles : of what use are the bacteriologists if they cannot provide each county with its special cheese-bug, to be brandished against all comers from outside ?

Our milk production should be strictly correlated with and regulate our output of meat—of veal, beef and pork, even of poultry and eggs. Butter involves butter-milk and its use in pig and poultry keeping : not an ounce should be wasted. That Rothamsted should spend time and money in show-

ing how it may be made harmless before turning it into a stream is nothing short of criminal condonation of manufacturers' ignorance. Verily is milk a dainty dish to set before king and nation!

Sugar may come next. We shall have to take this seriously, not as mere sweetness. In Europe it can only be produced at an economic loss; it has always been bounty fed. It may have agricultural advantages and suit our farmers under present conditions—but Peter is robbed to pay Paul, the community bears the brunt. Sugar can be made from sugar cane, at half the cost of beet sugar, in the West Indies, Java, etc. We cannot but purchase some foreign goods in exchange for our manufactured goods is not sugar one of the articles we should agree *to purchase*, on this account? There is no question of sweated labour to be considered: sunlight and the associated conditions in tropical countries all prevail against the economic cultivation of sugar here.

Maybe we shall soon be led to discourage the consumption of sugar and reduce its use to a minimum. Evidence is accumulating that it is an undesirable, if not a bad food, except when used to meet the strain of extreme muscular exertion, as in racing or climbing. The rise in the consumption of sugar, in modern times, is remarkable, especially in the United States; coincidently, there has been a marked fall in the amount of bread eaten. Americans are directing attention to a surprising change in national type—to the growth of obesity and even flabbiness in character. Are we not also losing character and becoming sugary in outlook? Sugar definitely spares fat—women are right in avoiding it, on this account. Worst of all, we starve ourselves in eating sugar in any quantity: it carries nothing with it—no mineral matter, nothing that is body building. On this account it is bad for children. Finally, it is probable that resistance of infectious disease is lowered by an excess of sugar in the blood.

Follows bread. Society has a heavy indictment to bring against the medical profession in particular, in that it has so long allowed the use of white wheaten flour as bread—that it has not insisted on as much as possible of the whole grain being eaten. The faults of white flour are those of sugar—it is mainly of use as fuel and has little nutritive value. It is truly a whited sepulchre! Nearly the whole of the mineral matter and the vital components—the germ—are removed in the bran, which is not eaten but sold as offal, for use by animals; these get the best of the bargain. The use of such flour is traceable to American laziness, to the desire to avoid hard labour by the use of machinery, also the desire to do big business and supply the world—without counting the loss to American soil or European farmers. Wholemeal flour cannot be kept more than a few weeks, as the oil in the germ becomes rancid; white flour, being free from the germ, may be stored over long periods—it therefore suits the milling and baking trades. Canadian hard wheats have also an unfair advantage, in that the flour will carry more water: the

baker can make more loaves from the sackful. Bread to-day is made *en bloc*—by machine : it is crustless and uninviting, as well as of minimum nutritive value. We need to go back to the local mill and the local baker—who together can give us a seemly loaf, of a bread containing as much of the cereal grain as may be eaten profitably. May be as good, if not better, breads may be made from home-grown than from imported wheats—putting aside all question of their water-carrying power.

Although Rothamsted has grown wheat on the same land, under like conditions, during more than ninety years, with great show of statistics, nothing has been learnt of the nutritive value of the grain. In any case, not a sack of flour should be allowed to come into the country—only grain, to be ground here. Our present fiscal policy will need drastic revision, if our knowledge of food be allowed to play any part in determining its character and scope. So will our agricultural research.

Last, but not least, " 'tis but the means to do ill deeds that makes deeds ill done." This applies equally to the good deed of growing high quality crops : to water and manures, without which, in due reason, nothing is possible. Agriculture has two great problems to consider—that of water supply and that of waste-disposal. Neither can be discussed here. Suffice it to say, we cannot afford, any longer, *to waste organic matter:* we must have humus manures, if we are to put quality into agricultural produce, especially into table vegetables. All town waste must be collected and specially treated : Sir Albert Howard and others, working in India, have shown how this can be accomplished. Our people will perish, not from lack of knowledge but of organic manure, if this be not soon done. In addition, we cannot any longer allow sewage to go to sea : we must in some way recover from it both potash and phosphate, of which the natural stores are very limited. China calls to us, offering an example of thriftiness that we shall be compelled to follow. Our agricultural research stations fail us, not only in this particular but generally in matters of food production. They offer us only bare figures. Man unfortunately lives not by statistics.

A great renascence awaits us. We have to brush the pedant aside and make our universities of avail in the service of the nation. Education at the present day is worthless for all practical purposes ; its fulcrum, in future, must be the belly through favour of the farmer.

SUGAR CONSUMPTION IN THE EAST*

THE densely populated countries of monsoon Asia, containing half the world's population, are frequently referred to as great potential markets for sugar, as for other products. These optimistic estimates are, however, based more often than not on the mere fact that the populations of these lands are very large— probably not less than 450 millions in China and 353 millions in India (1931) -and on the vague assumption that such large numbers must in the not far distant future mean correspondingly large consumption of the particular commodity. We may recall the well-known assumption that was for long the golden dream of the cotton industry— "if every Chinese were to add an inch to his shirt . . ." Only in the last few years has statistical knowledge begun to be available regarding the actual standards of living and habits of expenditure in the Eastern countries. Such data as have been obtained, though applicable only to relatively small samples of the respective populations, provide a valuable corrective to the superficial estimates and surmises that have prevailed.

Data concerning the actual consumption of sugar, difficult enough to obtain in Western countries, are obtained only with the greatest trouble in the East, where the physical and social conditions make the ignorance on the subject more excusable than in the West. Particularly is this the case in China, where internal communications are so poorly developed and, largely in consequence of that, control by the central government over the different parts of the country is very weak. The efforts of Government and University departments to obtain such information are met with suspicion, due largely to the belief that such enquiries will be followed by taxation. The fact that the overwhelming mass of the population in most of these regions is composed of small cultivators, working on a family basis with relatively little mutual contact, adds to the difficulty. In some areas, too, many of them grow sugar cane on their own holdings and eat some locally prepared form of sugar, such as the *gur* of India, besides chewing cane. Even where data of "sugar" consumption are available there is generally the difficulty that many different grades of crude and brown sugar, varying from place to place and not strictly comparable, are included, while in addition account must be taken of the considerable amounts eaten in candy and sweetmeats. On the other hand, given the limited industrial use of sugar, trade statistics are probably, as far as they go, more indicative of direct household consumption than they are in Western countries. For any real study of the prospects of consumption in a particular country, it is, however, necessary to analyse the actual data of consumption as between different areas and social classes.

*By C. J. Robertson, B.Sc., M.A., Ph.D., in *The International Sugar Journal*, Vol. XXXVII, No. 442, October, 1935.

For this purpose the most valuable data available are therefore those of the sample investigations of family budgets that have been carried out in certain areas. Amongst the principal studies of this kind in the last few years have been, in China, those of Prof. J. L. Buck of Nanking University on 1070 farm families in six hsiens and four provinces in North and East Central China in 1922-25, and those of the Peiping Institute of Social Research on 230 families of cotton-mill workers in Shanghai in 1927-28 and on 48 families in Peiping in 1926-27 ; in Siam those of C. C. Zimmerman in 1930-31 ; in Burma those of J. J. Bennison of the Labour Statistics Bureau on 4309 working families in Rangoon in 1928 ; in Java those of J. J. Ochse and G. J. A. Terra on 15 peasant households in 1933-34 and five non-peasant households in 1932-34 in the district of Koetowinangoen in the Regency of Keboemen (Middle Java) ; in India the series of studies of Punjab villages by the Board of Economic Enquiry, Punjab, from 1928 onward.

Taking these studies as a whole, one of the most obvious deductions that may be made is that in no case is sugar an essential part of the diet in the areas concerned. In J. L. Buck's comprehensive study of peasant families in China sugar is found to average 0·2 per cent. of the total energy value of the food, and in Peiping exactly the same percentage results. In Shanghai the figure rises to 0·6 per cent., while amongst the Mid-Java peasants it averages, for direct consumption, only 1·9 per cent. of the total calories. In the different racial groups of working families studied in Rangoon, the percentage of sugar and gur together ranges from 1·5 for Hindustanis to 2·5 for Chittagonians. Indian troops receive in their peace-rations 4·9 to 5·0 per cent. of their total calories in sugar while with tenant-cultivators in the Punjab the figure rises to 9·2 per cent. For comparison, the following data for two high-consumption, one medium-consumption and one low-consumption non-Asiatic countries may be given.

Percentage of Total Calories from sugar

Australia	20·6
United States	10·0
Germany	4·4
Italy	1·6

The high percentage of cereals and vegetables in the diet in some parts of Italy approximates most closely to Asiatic conditions. Apart from the inclusion of sugar in the Indian Army ration, the only evidence of its deliberate use as a source of energy is in the Punjab, where it is eaten by small owners and well-to-do tenants in the village of Tehong (Jullundur) after a hard day's work, the amount being doubled during the period of cane-harvesting, and is also given to pregnant women. Comprehensive date are also available, particularly for Siam, regarding the percentage of total cash expenditure on food that is spent on sugar but, as the cash expenditure on food depends very largely on the quantities of staple foods grown by the farmer himself and used for family consumption, these data cannot be directly compared. The absolute expenditure per family per annum on sugar in 1930-31 ranged from 6·35 baht in Central Siam to 0·82 baht in Northern Siam.

As in the West and to a still greater degree the rate of sugar consumption varies with class. In fact, not only the amount of sugar but its quality so varies. In Peiping, out of 48 labourers' families, 12 purchased white sugar, 39 brown sugar and 10 candies, the average monthly amounts consumed per family amongst the total being in six months of winter and spring 0·1 kg. white, 0·5 kg. brown and 0·4 kg. candies. Of twelve teachers' families, however, ten purchased white sugar and one brown sugar, the averages being 0·3 kg. white and 0·05 kg. brown. In Shanghai also there was found with increase in income a steady rise of expenditure on sugar. In Poona only the rich use sugar as distinct from gur. The data for Tehong in the Jillundur district of the Punjab illustrate the social classification very well.

Consumption of sugar and gur in ounces per month

	Males	*Females*
Well-to-do landowners (over 15) ..	96 ..	80
Well-to-do non-agriculturists (over 15) ..	56	
Small owners and well-to-do tenants (25 to 55 ; gur only)	64 ..	48
Artisans (over 15 ; gur only)	64 ..	48
Leatherworkers (25 to 55)	56 ..	40
Village menials (25 to 55)	40 ..	32

In Gajju Chak (Gujranwala) the well-to-do landowners eat gur every two or three days during Ramzan, the small owners and well-to-do tenants gur once in two months, the small tenants and agricultural labourers (unless the reapers during wheat harvest) only occasionally. In Kalu Gaddi Thamman (Lyallpur) the well-to-do landowners, small landowners and well-to-do tenants and small tenants and artisans eat brown sugar, the labourers gur. The Rangoon investigations show that Tamil coal or padi carriers and Hindustani factory workers eat only gur, while Uriya tramway workers and Hindustani durwans, peons and gharrywallas eat only refined sugar ; amongst the various races as a whole, the rate of consumption is highest amongst the Uriyas. The observations of workers' families in Mid-Java also show a clear connexion with status. In the city of Poona data collected by D. L. Sahasrabudhe offer a good example of associated consumption with tea, the *per capita* rate amongst tea-drinkers being 21 to 57 lb., while that amongst others is only 4 to 8 lb. and the proportion of sugar to gur amongst the former varying between 3·4 units of sugar to one unit of gur, and 1·6 units of sugar to one of gur, while amongst the latter it is one unit of sugar to three of gur. In the nine villages studied near Poona by the same investigator, the proportion of sugar to gur was found to be 1·14 units of sugar to one unit of gur. There is in all the countries concerned and particularly in the towns also a desultory consumption of small amounts of sugar as a component of sweetmeats bought in the streets between meals. Consumption of candy is also of this character.

The luxury character of sugar consumption in these countries is also well illustrated by its seasonal or occasional variation. In China consumption rises to a maximum at the period of the New Year festivities (January). In Java, too, the larger expenditure on sugar on the occasion of festivals is noted. The Punjab studies show that while normally brown sugar is eaten,

even amongst the well-to-do non-agriculturists, or gur, amongst the small tenants and agricultural labourers, white sugar is given to guests. The amount of this luxury consumption depends in part on the season's crop results, a good season with a larger surplus for sale or higher prices enabling larger amounts to be spent on festivities and small luxuries such as sweetmeats. Even amongst the well-to-do, in fact, variation in diet appears to be of this very occasional character, the normal diet, predominantly of cereals and legumes, remaining very constant in the proportions between its constituents. Amongst the poor the extent to which the diet approximates to the minimum of subsistence is illustrated in the Punjab by the case of the casual village menials in Tehong, where it is observed that even in times of scarcity there is little deviation from the accustomed standard.

These investigations for the most part cover only a small proportion of the country concerned, particularly in China, where the vastness of the country, the great variation in regional conditions and the poor communications make the applications to the country as a whole, even of the results obtained in the rural areas, all the more inappropriate. Only in the Siam study is an attempt made to cover the whole country and in this case the figures of cash expenditure on sugar and the percentage of families buying the commodity show the difference between the areas where communications are better, and where in consequence agriculture is more commercialized, and the more isolated areas in the interior.

	Percentage of families buying sugar	Expenditure on sugar per family per annum in baht
Central Siam	96·50	6·35
Southern Siam	92·75	2·41
North-Eastern Siam	68·62	0·88
Northern Siam	51·00	0·82

Though as a whole only an exceedingly small proportion of the total energy-value of the food is in Eastern countries obtained from sugar in its various forms and it is not generally regarded as an essential part of the diet, the evidence of increased consumption with higher cash income (as the result of higher class, of good crop years or of the better facilities for trade in certain districts) and of its use on festive occasions even by the very poor shows that there is a great potential demand, that the masses would gladly relieve the monotony of their cereal diet with such a condiment and that the main obstacle is the financial one. Sugar consumption in the East is in fact an even more delicate index of standard of living that it is in western countries because of the wider gamut, depending not merely on quantity but on quality, from gur through brown sugar to white and refined. Analysis of the statistical data from these countries shows that the desire of the poorer classes to imitate the consumption habits of the richer is just as strong in the East as in the West. The success of the kerosene and cigarette companies in China demonstrates the power of an efficient distributing system and adequate propaganda as catalytic agents. Possibly sugar suffers and would continue to suffer, even if such methods were available, owing to the fact that its consumption is not so conspicuous and does not therefore give the same social satisfaction.

With or without efficient propaganda, however, there exist tremendous obstacles to any even moderately rapid conversion of the undoubted potential demand into an effective one. In the case of China, for instance, the vast population so often cited as an index of this demand, is itself an *obstacle* to increase in consumption. There is a consensus of opinion that the pressure of numbers on the land is the the principal factor depressing the standard of living, a large proportion of the population living constantly on the fringes of famine. Large-scale industry in China directly concerns only about 1 per cent. of the total population and there, too, incomes are very low. Increase in population, by further lowering the standard of living and even driving still more below the famine line, does not in such a country raise but *lowers* the consumption of goods other than absolute necessities. Not only the prime factor of over-population lowers standards of living. There are also social factors such as the oppressive family system, excessive taxation and the demands of middle-men; poverty in communications; lack of technical skill and low yields; flood and drought. Not only in China but in many other areas in the monsoon countries similar depressing factors are met with. These general considerations, taken in conjunction with the lowness of the actual rates of sugar consumption in the more accessible areas discussed above give ample reason for pausing before accepting the easy optimism with which the great populations of the East are sometimes presented as immense markets for the near future.

BREAST MEAT IS AN ESSENTIAL FOR BREEDING STOCK*

IT has often been said that the " egg " type of bird and the " table " type are direct opposites—the former being always lean and the latter well fleshed. Quite naturally, there are birds which are of the beefy pattern, and, therefore, likely to put on or make surplus flesh, just as there are productive fowls by build which direct most of their energies to egg-making.

An experienced handler, however, can tell one from the other if he possesses, as he should, the desired touch. The pullet likely to make eggs and not put on a surfeit of internal fat will reveal at maturity a thin, silky skin and excellent pliability at abdomen directly underneath the pelvic bones; the wattles, too, will be close together. To avoid the beefy pullet, likely instead to get overfat with low production, one learns to dislike thick, fleshy skin, widely placed wattles, and any hard, meaty feeling below the pelvic bones when the bird is ready for laying.

In trying to avoid the beefy type the utility breeder must be careful not to swing over to the other extreme and select the bird with a fleshless breast-bone. It is so easy to do this if looking for the lean pattern. In that direction lurks serious trouble, particularly in the form of worms, coccidia, and the like, yet I find breeders none too careful about it.

When it is known that a flock of pullets is affected with worms or other intestinal disorders they seem suddenly to go to pieces, and when picked up for handling very many are only skin and bone. Actually, this serious loss of flesh and condition goes on for some time unnoticed, probably because the growing pullets look healthy to the eye. Then, when badly affected as laying approaches or begins, they waste away. Perhaps one or two are noticed to walk lame or to go down with paralysis, and they are taken in the hand for the first time, when their wasted condition surprises their owner.

All things considered, I say candidly that there never was a time when body size and breast fleshing counted for more in poultry breeding than to-day. Soon every breeder will be called upon to mate up his breeding pens, and my remarks should then be kept very strictly in mind.

When going through the cockerels to decide which to use for stock, always keep clear of under-sized specimens. A bird that is in any way deformed usually fails to make maximum growth ; weaklings finish short of the required size . . . all with internal disorders have the same failing. These are reasons why breeders who are fond of body size in their stock have strong and sturdy strains ; they are passing over undesirable specimens.

The time to commence the first culling obviously is during the growing stages, when all the chickens of a certain hatch are running together. Those which are head and shoulders above the rest can then be picked out quite

*By W. Powell-Owen, in *Poultry World*, Vol. 56, No. 26, Friday, October 25th, 1935.

easily for future consideration as breeders. The under-sized ones are equally outstanding to the eye at that time and can be marked as undesirable stock-getters.

To endeavour to sort them out when the individual batch is separated is not without its problems ; only where wing bands are employed can one be sure of exact ages, and, of course, when toe-punch marks are planned to represent the month and the particular hatch therein.

NO EXCUSE FOR LACK OF SIZE

Never excuse a cockerel or pullet for being under-sized by persuading yourself that the bird is a late-hatched one, purely on guess-work. Do not excuse thin cockerels with breasts devoid of flesh by trying to suggest that they are poor from roughing it and through running in large flocks or fighting. One can best check that up by trying a more liberal ration on such birds after taking them from the flock and keeping them on their own. If your first surmise is correct they will start to pick up flesh and condition at once. Should there be internal disorder they will show no improvement.

Do not attempt to excuse individual pullets for having fleshless breast-bones through heavy laying : that is far too common. If persevered with, disease will not be recognised when present. The pullet which goes to skin and bone after a heavy spell of laying must make a most undesirable breeder because of that. The ideal pullet to qualify as a future breeding hen should be capable of holding her weight under heavy production. Efforts have been made to popularise this latter class of bird ; no better type could be selected and I commend the principles as sound.

When putting pullets into trap-nest houses see that they are well fleshed about the breast-bones ; make sure of their capabilities to hold up under all strains, including that of heavy egg production. When trap-nesting, be always looking for this desirable class of pullet and mark it for consideration later for reproduction.

In face of our present day troubles I would stress the importance of breeding from adult hens. One used to declare that when pullets were three months or so of age they were to all intents and purposes reared. That may have been true then. Pullets are not over their troubles to-day until they have had their complete adult moult and come through into laying condition as strong and vigorous second-year hens.

They can go wrong just as laying is about to commence ; many merely fade away. They can die during the summer, breaking down after winter production ; they can finish the season's lay in a mighty weak condition bodily or physically. Further than that they can fail to pull through the moult, weakened by the pullet season's egg production.

It is not my policy to shout disease, but I would refer readers to the laying tests now under way. Watch any ten pens and note the results as each month goes by. Some of the pullets competing in those ten pens will die ; a number will lay exceptionally well for four, five and even six months and then fade out without any apparent explanation. Probably one or two will go blind, or end up fleshless in the hospital pens. On the final day any large laying test has its hospital cases—birds able just to live out the three hundred and thirty-six days.

A farm is no different to a laying test, and the risk run in breeding from pullets is fairly obvious. A host of chicks are hatched out in the spring,

and soon after the dams die or go wrong, and it is impossible often to collect their offspring, these having been scattered over the farm. Even when the chicks are wing-banded so many will not bother to eliminate such progeny from future breeding pens. If one is prepared to recover any lost ground by doing this, a different case can be made for breeding from pullets. Even then they should be most carefully chosen individuals.

The advantage of breeding from second-year and older hens is now obvious. They have survived all the recognised chicken ills, outlived the strain of high production, and successfully bridged the moult. The pick of them have proved their mettle as long-livers and disease resisters—can we shut our eyes to such practical facts to-day when so much is written about disease and experienced by so many ?

During the past season very many of our large pedigree breeders have gone back to their adult hens for breeding. Particularly has this happened where difficulties in rearing or weaknesses have been met with. As far as those amongst my intimate friends who have adopted this fixed policy are concerned, I can give you their expressions of opinion. They are summed up in the following. " Rearing has been just a pleasure and not a nightmare."

Isolate every purchased cockerel and feed it up well. Handle it regularly and do not use it or run it with any home stock until you are sure it retains and obtains a well fleshed condition from good feeding. That is the way to play for safety. If in time it goes light, loses flesh on the breast-bone, and begets an unhealthy appearance about the comb or face, well, cut your losses, kill the bird, and burn the carcase. Give the run a thorough rest and the cockerel-box a sound cleansing.

Cockerels on range might be fed liberally to flesh them up so that one can check up the response to improved feeding, including wet mash. That is why the best should be placed on their own in cockerel-box and small runs. A reason, too, why small, select lots are much better than large single groups. They can be the more easily conditioned by feeding and are more closely under observation individually.

Watch just now for any unhealthy appearance of the head points of any cockerel being reserved for stock. Handle each bird for condition very regularly and thus keep a check on one's stock. Under-rationing will supply no key to fleshless breast-bones : it will rather fog one. Feed up the cockerels and then apply the test.

WHAT IS A WEED?*

AT the present time a great deal of interest centres in weeds, especially in the control of some of the most obnoxious ones. The question arises, therefore, what is a weed? Perhaps the question is more or less academic, since so far as the serious weeds are concerned at least, there is no dispute as to what they are and that they are serious weeds.

Agronomists should, however, be able to define their concepts as comprehensively and accurately as possible and hence it may not be out of place to renew the inquiry as to the proper definition of a weed. Is it possible to frame a definition at once inclusive and exclusive? The brief discussion herewith covers an attempt to analyze the definitions current or proposed; to point out in what particular they are unsatisfactory and to raise the question whether a better definition can be framed.

The late Dr. Beal, of blessed memory, was the one who offered the definition which has been pretty generally accepted. He said a weed was a plant out of place. While this definition has a great deal to recommend it, it has always seemed to the writer somewhat unsatisfactory. The term "weed" is an odious one and carries with it inevitably the idea of something evil, of something that does harm and should be destroyed. Dr. Beal's definition makes the matter depend on where the plant is found and according to that definition the same plant might at one time be a weed and at another, not a weed. Buckhorn, thistle, and crabgrass would, under this definition, be weeds when found in cultivated fields but when growing along the roadside or in waste places, they would not be weeds. On the other hand, red clover in a garden would be a weed. Except as a concept of the human mind no wild plant is out of place. It is merely a part of the general scheme of nature.

Dr. Beal's definition depends on the place where a plant is found, not upon any character inherent in the plant.

The writer has been very much interested in speculating on this point because in his own garden white clover, bluegrass, and the American elm make more trouble than any other plants. In this garden are two large elm trees which bloom abundantly every spring and in a few weeks after blooming the lawn and the garden are covered with young elm seedlings. These are certainly out of place, and in the hardy herbaceous border they make a great deal of trouble because each seedling must be picked out individually from between the clumps of hardy perennials. Still, the American elm is certainly not a weed.

It is so with white clover and bluegrass. The more the garden is fertilized the more white clover and bluegrass creep in among the hardy perennials, and it is a constant fight to keep these invaders subdued. At the same time, it is doubtful whether any agronomist would commonly think of these plants

*By A. J. Pieters, Principal Agronomist in charge, Division of Forage Crops and Diseases, U.S. Dept. of Agriculture, Washington, D.C., in the *Journal of the American Society of Agronomy*, Vol. 27, No. 10, October, 1935.

as weeds, in spite of the fact that they are decidedly out of place in the hardy border and cause the gardener a great deal of trouble.

Webster defines a weed as "any plant growing in cultivated ground to the injury of the crop or desired vegetation or to the disfigurement of the place; an unsightly, useless or injurious plant." The great majority of plant species are useless to man, most are unsightly at some stage, and there are injurious plants, as some poisonous ones, that never invade cultivated fields. In the corn belt, and elsewhere in the humid East, Kentucky bluegrass grows among alfalfa to the detriment of that crop and if this is called a weed, we are back to Beal's definition and then a plant may be a weed one place and not in another.

The Oxford dictionary says that a weed is "a herbaceous plant not valued for use or beauty, growing wild and rank, and regarded as cumbering the ground or hindering the growth of superior vegetation." Under this definition would Johnson grass be a weed? It certainly is valued as a hay plant, but it is equally true that under some circumstances it hinders the growth of superior vegetation.

Bailey in his *Cyclopaedia of Horticulture* frankly states that a plant may be a weed in one place and not in another, and continues: "There are, of course, species that are habitual weeds; but in their wild state where they do not intrude on cultivated areas, they can scarcely be called weeds." It is clear that Dr. Bailey does not think it possible to define a weed except in terms of location.

In U.S. Dept. of Agriculture Farmers' Bulletin 669 (1915), entitled "Weeds: How to Control Them," by H. R. Cox, the definition of a weed suggested by J. Sidney Cates, is "a wild plant that has the habit of intruding where not wanted." This definition carries the same thought as that expressed by Dr. Beal, but goes further and attributes a "habit of intruding" to the plant. But here, too, it may be noted that Kentucky bluegrass has, in the corn belt, the habit of intruding on alfalfa fields.

None of the definitions so far considered get away from the thought that a plant may be a weed or not a weed, depending on where it is. According to these definitions valuable plants like white clover or Kentucky bluegrass may be called weeds, while buckhorn, Canada thistle, and others growing in waste places would not be weeds.

The underlying thought in the use of the word "weed" by the people for more than thousand years has been that of an undesirable plant; not one unwanted here or there, but one fundamentally bad. Such a plant as a thistle was a weed. Such a plant as white clover, well known hundreds of years ago was not called a weed and, of course, Kentucky bluegrass and Johnson grass were not known. Established usage is the foundation of usage in the English language, but new plants not known to the English of the 10th and 11th centuries and new agricultural practices may make it necessary to broaden our concept of what a weed is.

The Forest Service classes all plants on the range as "grasses," "grass-like plants," "trees and shrubs," and "weeds," the latter term covering all other herbs. This is obviously a definition of convenience and without any bearing in the usefulness of the species. It would be better usage to substitute "forbs" for weeds.

Is it possible to get away from this anomalous situation and make a definition that will exclude from the opprobrious term "weed," plants that sometimes grow where they are not wanted? Perhaps this is not possible but the writer would like to have agronomists consider this question anew and as a contribution to the discussion suggests that "a weed is a plant whose potentialities for harm are greater that its potentialities for good." According to this definition, white clover would not be a weed even though it is annoying at times, because its extreme usefulness far outweighs the little harm it does. On the other hand, the Canada thistle would always be a weed no matter where it was because it does a great deal of harm and no good. There will, of course, be some plants as Johnson grass in the South on which there might be a dispute. While Johnson grass is an unmitigated nuisance in cultivated fields, it does provide quite a bit of grazing and in some parts of the South it provides some hay. It is quite certain, however, that farmers would gladly dispense with Johnson grass for hay if there were any way to destroy it utterly; it does more harm than good.

The writer realizes that the application of the definition offered depends on our knowledge of a given plant. This may be incomplete, but so soon as the characteristics of a plant become well known it should be possible to place it in its proper classification, and a weed would be a weed even though temporarily useful to man: a plant like white clover would never be called a weed though it might be temporarily annoying.

Attention is called once more to the fact that in long established usage the term "weed" did not mean "a plant out of place," but meant an injurious plant with no good in it. The term "a plant out of place" is a catchy one but does not conform to ancient usage and permits the inclusion of useful plants among weeds because the useful plants sometimes grow where not wanted.

Possibly a modification of the definition in Farmers' Bulletin 660 might meet the case and we might define a weed as "a plant that does more harm than good and has the habit of intruding where not wanted."

MEETINGS, CONFERENCES, ETC.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the twenty-ninth meeting of the Board of Management held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 10 a.m. on Thursday, 7th November, 1935.

Present.—Dr. J. C. Hutson (in the chair), Mr. C. H. Collins, C.C.S., (Deputy Financial Secretary), Messrs C. E. A. Dias, J.P., L. B. De Mel, J.P., U.P.M., George E. de Silva, M.S.C., L. P. Gapp, F. H. Griffith, Col. T. G. Jayewardene, V.D., M.S.C., Messrs J. L. Kotalawala, M.S.C., R. N. Rolfe, E. C. Villiers, M.S.C., E. W. Whitelaw and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director of Research was also present by invitation.

Apology for absence was received from Mr. C. A. Pereira.

MINUTES

Minutes of the last meeting which had been circulated to members were signed and confirmed.

BOARD

The Chairman welcomed Mr. F. H. Griffith and Col. T. Y. Wright who had resumed their seats on return to the Island as from October 1st and 23rd respectively, and thanked Mr. G. E. Venning and Mr. R. A. Sharrocks who had acted for them.

OIDIUM CONTROL

Referring to the decision reached at the last meeting to apply for a grant of Rs. 20,000 from the restriction fund to carry out a scheme of sulphur dusting in the Central Division during the 1936 refoliation season on a contributory basis, the Chairman reported that enquiries made by the Divisional Agricultural Officer showed that small holders were not prepared to make any contribution to the cost of treatment and only a few proprietors of small estates had agreed to do so.

After discussion it was decided to proceed with the scheme (subject to funds being allotted) without charging for the treatment, in order to demonstrate the value of sulphur dusting and to gain experience of the type of organisation required for large scale dusting operations. It was noted that the scheme could only be carried out if funds are allocated before November 30th.

ACCOUNTS

(*a*) *Estimates of Income and Expenditure for* 1936.—Draft estimates which had been circulated to members, were considered in detail. After discussion the following estimates were adopted :—

Income			Rs. 170,600
Expenditure recurrent ..	Rs. 139,695		
Expenditure non-recurrent ..			
Buildings	Rs. 57,885		
Equipment	Rs. 8,000		
Agricultural Development..	Rs. 8,269		
Extension of cart-road ..	Rs. 4,000	..	Rs. 217,849

Non-recurrent expenditure includes provision for extension of the main laboratory block and construction of one senior staff bungalow, head clerk's bungalow and three junior staff bungalows at Dartonfield : with a view to completing the transfer of headquarters to the estate in 1937.

Provision is also made for replanting ten acres on experimental lines and completing an inspection road through the estate.

(*b*) *Statement of Receipts and Payments of the Board for the quarter ended 30th September,* 1935 was adopted.

(*c*) *Dartonfield and Nivitigalakele Accounts* for August and September, 1935 were tabled.

PUBLICATIONS

(*a*) Combined 1st and 2nd Quarterly Circular for 1935 and Leaflet No. 14 (revised edition) " The sulphur dusting treatment for oidium " were tabled.

(*b*) It was decided to accept contributions to the Quarterly Circular from persons other than Research Scheme officers, at the discretion of the Director and subject to the proviso that the Board does not take responsibility for the views expressed in such articles.

(*c*) It was decided to accept advertisements for inclusion in the Quarterly Circular, at the discretion of the Director.

STAFF

The service agreement signed by Mr. C. A. De Silva, Assistant Botanist was tabled and the Chairman and Mr. C. H. Collins were asked to authenticate the Board's seal on the document.

FIELD EXPERIMENTS AT DARTONFIELD

Detailed proposals for a tapping and a manuring experiment in mature rubber, which had been drawn up by the technical staff and approved by the Experimental Committee were considered and approved.

Details of the replanting experiment to be carried out in 1936, comparing three methods of opening the land, three methods of planting and the efficiency of organic and inorganic fertilisers, were discussed and approved, subject to the dissent of one member who considered that the layout of the experiment was unsatisfactory.

RUBBER FLOORING COMPOSITIONS

Specimens of rubber flooring tiles compounded with coir residues were exhibited by Mr. Philpott who explained the method and probable cost of manufacture. The possibility of preparing the material on a semi-commercial scale to demonstrate the practicability of the process was considered and it was decided to discuss the matter in detail at a meeting to be held in December.

The meeting closed with a vote of thanks to the Chamber of Commerce for the use of the Committee room.

TEA RESEARCH INSTITUTE OF CEYLON

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon, held in the Ceylon Chamber of Commerce rooms, Colombo, on Saturday, the 9th November, 1935, at 10 a.m.

Present.—Mr. James Forbes (Jun.) (Chairman, T.R.I.), The Hon'ble the Financial Secretary, The Director of Agriculture, Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs E. L. Fraser, R. P. Gaddum, C. E. Hawes, J. D. Hoare, D. H. Kotalawala, M.S.C., D. T. Richards, S. C. Bisset (Secretary), and by invitation Dr. C. H. Gadd and Mr. A. K. Halliley (Acting Secretary, Planters' Association of Ceylon).

Absent.—Col. T. G. Jayawardene, V.D., M.S.C., and Mr. A. H. Reid.

1. Notice calling the Meeting was read.

The Chairman apologised to the Board for any inconvenience members may have been caused through his recent illness.

2. The Minutes of the Meetings of the Board of the Tea Research Institute of Ceylon, held on the 21st September and 26th October, 1935, were confirmed.

3. MEMBERS OF THE BOARD OF THE T.R.I.

The Chairman welcomed the Hon'ble Mr. H. J. Huxham on his return from furlough and recorded a vote of thanks to Mr. Collins for his services while acting for Mr. Huxham.

The Chairman also extended a welcome to Mr. C. E. Hawes and thanked him for having agreed to act during the short period of Mr. I. L. Cameron's absence as from the 19th October to the 13th November, 1935.

It was announced that the Low-country Products' Association had nominated Col. T. G. Jayawardene, V.D., M.S.C., for a further period of three years as from the 25th September, 1935.

Acting Chairman, T.R.I.—A vote of thanks was recorded to Mr. R. P. Gaddum for having acted as Chairman of the Institute during Mr. James Forbes' illness.

4. FINANCE

Statement of Accounts as at 30th September, 1935, a copy of which had been sent to each member of the Board on the 30th October, 1935, was adopted without comment.

5. SENIOR SCIENTIFIC STAFF

(*a*). *Director, T.R.I.—Dr. Roland V. Norris.*—Announced that Dr. Norris was on sick leave and that Dr. Gadd was acting as Director as from the 29th October, 1935.

(*b*). *Agricultural Chemist—Dr. T. Eden.*—The Chairman stated that Dr. Eden had proceeded to Tocklai on the 30th October and that Dr. Tubbs was acting for him.

JUNIOR SCIENTIFIC STAFF

Research Assistant, Department of Agricultural Chemistry—Dr. J. G. Shrikhande.—Announced that this officer would be taking up duties as from the 1st December, 1935.

6. SECRETARY, T.R.I.

The Chairman announced that Mr. A. W. L. Turner would be returning to duty on the 20th November, and relieve Mr. S. C. Bisset, who had been acting for him as Secretary of the Institute.

The Chairman personally and in the name of the Board thanked Mr. Bisset for his services. He also thanked Mr. Halliley, Acting Secretary of the Planters' Association of Ceylon for his services.

S. C. BISSET,
Secretary.

REVIEWS

IMPERIAL ECONOMIC COMMITTEE

Annual Report covering the period 1st October, 1933 to 31st March, 1935

A STEP IN IMPERIAL CO-OPERATION

AN important reorganisation of the constitution and work of the Imperial Economic Committee is described in a report which that body has just issued.* Though intended to be the first of a series of Annual Reports on the Committee's work, this report actually covers a period of eighteen months, during which the Hon. G. H. Ferguson, High Commissioner for Canada, has been Chairman.

The Imperial Economic Committee was established ten years ago as a result of decisions reached by governments following discussions at the Imperial Conference of 1923. Successive Imperial Conferences amended its constitution and widened its functions. Early in 1933 its constitution and functions were again surveyed by the Imperial Committee on Economic Consultation and Co-operation which met in London in pursuance of a resolution adopted at the Ottawa Conference. In April 1933 this investigating Committee presented its report, in which emphasis was laid on the need for Imperial co-operation both in regard to scientific investigation and economic enquiry, and a further point made that the existence of national intelligence services and agencies for market promotion did not imply that there were not branches in the field of market intelligence and market promotion in which co-operative action between the peoples of the Commonwealth was desirable. No attempt was made to define in detail or for all time, the field of co-operation in economic enquiry. Instead, the Committee preferred—

(*a*) to select from the activities which came under its examination those which, in its opinion, should forthwith be continued on a co-operative basis ;

(*b*) to provide power for the addition of new services and new activities on a co-operative basis as occasion needed and as governments from time to time should agree ;

(*c*) to establish the practice of financial co-operation in all such work ;

* Imperial Economic Committee: Annual Report covering the period 1st October, 1933 to 31st March, 1935; published for the Committee by H. M. Stationery Office, price 6d. net (8d. post free).

(*d*) to ensure observance of the principle of "equality of status" in the control of that work;

(*e*) to provide for "the careful and periodical examination at Empire conferences, suitable for the purpose" of inter-imperial activities conducted and organised co-operatively.

The Committee went on to consider the work and organisation of the Imperial Economic Committee and the statistical marketing intelligence and economic investigations conducted by the Empire Marketing Board, and finally recommended that the Imperial Economic Committee while continuing to discharge its former functions should take over from the Empire Marketing Board the preparation and issue of periodical market intelligence notes and world surveys of production and trade, and that it should be within the competence of the Imperial Economic Committee to make proposals to governments in regard to other economic services and enquiries which in its view should be conducted on a co-operative basis.

The recommendations were accepted by all governments and the Imperial Economic Committee was reconstituted with effect from the 1st October, 1933. The Committee then ceased to be the responsibility of His Majesty's Government in the United Kingdom and became the responsibility of the British Commonwealth of Nations. The composition of the Committee and the number of representatives of each part of the Empire are determined by agreement among the several governments on a basis of constitutional equality The several members of the Committee are each appointed by their own governments. Reports are addressed to all the Governments of the Empire. Finance is provided by all governments in agreed proportions and the resulting fund is controlled not by any one government but by all the governments, acting through their representatives on the Committee.

The present report shows how this reorganisation was affected, and how despite a very extensive change of staff the old and new work of the Committee was carried through without a break.

The staff, now directly appointed and controlled by the Committee, includes a notable proportion of officers either born in the Empire overseas or possessing overseas experience. The reorganisation necessarily tended to slow down work at first, but during the period reviewed the Committee issued to the governments of the Empire two reports after formal enquiry, one on Grassland Seeds and one on Maize, and two World Surveys, one on Cattle and Beef, and one on Ground Nut Products. It was also engaged on two Trade Surveys, on the Motor Car and Electrical Industries, and on a World Survey on Sheep, Mutton and Lamb. Over and above this, it has published regularly every week its Dairy Produce Notes and Fruit Intelligence Notes, and every month its Wool Intelligence Notes, and its Canned and Dried Fruit Notes (with a weekly supplement giving arrivals). In addition

annual summaries reviewing for the year the trade of the United Kingdom and other principal importing and exporting countries, with statistics of production in the chief producing countries, are issued as supplements free to the subscribers to the appropriate Notes, and are also available for separate sale. Between the 1st October, 1933 and the 31st March 1935, the number of subscribers to these Intelligence Services rose from 1,636 to 2,007.

The Committee is now Imperial in the fullest sense, since it is controlled and financed by all parts of the Empire, is available to examine and report on any economic question which the governments of the Empire may agree to refer to it, and provides regular economic intelligence services of value to all parts of the Empire. Mr. F. L. McDougall, C.M.G., (Australia) is Chairman for the current year.

BIBLIOGRAPHY OF SOIL SCIENCE, FERTILIZERS AND GENERAL AGRONOMY

The Imperial Bureau of Soil Science has recently issued a complete "Bibliography of Soil Science, Fertilizers and General Agronomy" covering the whole scientific literature of the world on soil and allied sciences during 1931-1934. This extremely comprehensive bibliography gives the reference to practically every paper published during that period on the different branches of soil science, both pure and applied, on the use of fertilizers, on the cultivation of all the chief economic crops (over 140, including forests, are listed in the index) and on plant diseases in relation to soils. The references are arranged by subjects according to the Universal Decimal Classification, which is adequately explained in the Preface. The volume also contains an index to the Decimal Classification, an alphabetical cross-index to every subject on which the papers listed have been written, an author index containing over 4,000 names, and a list of the abbreviations used, and the full titles and places of issue (where known) of 800 journals, etc. from which the references in the Bibliography have been taken.

The Bibliography has been compiled from the references which appeared in the first 41 issues of the Bureau's monthly lists of "Publications relating to Soils and Fertilizers." An unusual feature is that the literature of almost every country has been covered equally well, thanks to the exceptional facilities for procuring foreign periodicals which the Soil Bureau enjoys. Considering its scope and the amount of information it contains, the book has been made remarkably compact, without detriment to its readability. It should be a most valuable reference book to every agricultural scientist whose work is in any way connected with the soil. The Bureau intends to issue further similar bibliographies at intervals of 3-4 years, and in this way gradually to build up a complete reference library to the whole literature of the soil over an extended period of time.

Crown octavo, pp. 504. Bound in cloth, with gold lettering, price 25/- net, post free from the Imperial Bureau of Soil Science, Harpenden, England.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st DECEMBER, 1935

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st, 1935	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	43	..	43	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies (Dogs)	15	..	..	..	..	15
Colombo Municipality	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	25	..	24	1	..	..
	Anthrax	2	..	..	2	..	..
	Rabies (Dogs)	43	11	..	..	..	43
Cattle Quarantine Station	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	82	1	..	82	..	..
Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	67	26	55	..	11	1
	Anthrax	5	..	1	4	..	..
	Black Quarter	18	..	..	18	..	..
	Bovine Tuberculosis	8	..	..	..	..	8
	Rabies (Dogs)	2	..	..	..	..	2
Southern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
Northern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
Eastern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	40	..	40	..	..	..
	Anthrax	..	..	..	..	..	..
North-Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	222	22	211	5	6	..
	Anthrax	..	..	..	..	..	..
	Rabies (Dogs)	28	3	..	4	..	24
North-Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	1172	287	745	..	427	..
	Anthrax	..	..	..	..	..	..
Uva	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	85	..	84	1	..	..
	Anthrax	..	..	..	..	..	..
Sabaragamuwa	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Haemorrhagic Septicaemia	22	..	3	19	..	..
	Piroplasmosis	2	..	1	1	..	..
	Rabies (Dogs)	5	..	..	..	..	5

Government Veterinary Department,
Peradeniya, 20th January, 1936.

M. CRAWFORD,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT—DECEMBER, 1935

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	85·1	−0·4	73·3	+1·1	74	90	7·3	9·93	13	+ 4·29
Puttalam ..	84·2	−0·5	71·7	+0·7	79	95	6·4	3·22	19	− 2·98
Mannar ..	81·9	−1·5	74·7	0	81	88	6·9	12·09	16	+ 4·28
Jaffna ..	82·0	−0·2	72·8	+0·4	79	90	6·0	20·22	14	+10·77
Trincomalee ..	80·6	−0·3	74·3	−0·2	83	88	7·8	26·51	22	+13·90
Batticaloa ..	81·3	−0·7	73·7	+0·4	83	93	7·5	17·92	23	+ 0·77
Hambantota ..	83·3	−1·1	73·0	+0·4	80	93	6·1	13·73	13	+ 8·14
Galle ..	82·7	−1·1	73·6	+0·5	81	93	6·2	7·97	19	− 0·20
Ratnapura ..	85·9	−2·5	72·5	+0·9	80	95	6·7	9·14	23	− 0·06
Anuradhapura ..	81·6	−1·5	70·3	+0·7	83	95	7·8	10·33	22	+ 2·72
Kurunegala ..	85·6	−0·4	71·7	+1·6	74	90	6·4	7·14	16	+ 0·01
Kandy ..	82·4	−0·2	68·4	+1·1	74	90	6·7	12·98	20	+ 3·92
Badulla ..	76·3	−0·3	65·3	+1·1	82	95	7·2	13·61	23	+ 2·21
Diyatalawa ..	71·7	−0·3	59·2	+1·0	82	94	7·6	11·14	24	+ 3·03
Hakgala ..	66·4	+0·2	53·2	+1·7	87	94	8·4	21·08	26	+ 7·72
Nuwara Eliya ..	67·6	−0·6	49·6	+1·3	79	93	7·6	13·44	21	+ 5·42

The rainfall of December was generally above normal, the only appreciable areas below normal being two, one almost coincident with the North-Western Province, and another to the south and south-east of Colombo. Excess was most marked north of Mankulam, where several stations reported excesses of over 15 inches, and in the Trincomalee district, but was also fairly pronounced in the coastal districts south of Batticaloa, and on the eastern slopes of the hills. Deficits were greatest in the Puttalam district, and were elsewhere generally only slight.

The highest monthly totals reported were 46·02 inches at Hendon, and 44·84 at St. Martin's, no other station reporting over 37 inches.

There were 47 daily falls of 5 inches or over reported, mainly for the 13th and 14th on the east coast and the eastern slopes of the hills, and for the 18th in the north of the Island. The highest daily falls reported were 11·62 inches at Paranthan, and 10·65 inches at Kilinochchi, both for the 18th.

The dry spell which set in at the end of November continued until December 3rd, with night temperatures below normal, particularly up-country. From the 4th the rainfall increased, and on the 5th there was moderately heavy rain, widespread over a large part of Ceylon. For the next week heavy rains, often accompanied by thunderstorms, were reported from many places, particularly in or near the hills. About the 13th the monsoon strengthened, and the heaviest rains were now generally reported from the north and east of the Island, and the eastern slopes of the hills. On the 18th weather conditions were reported as unsettled in the Bay near Ceylon, with the likelihood of a depression forming. This failed to materialise, but there was widespread heavy rain, chiefly in the north and in the hills, on the 18th and 19th. The rain continued to be widespread, and fairly heavy in or near the hills, with thunderstorms, till the 28th, when another dry spell set in, with low night temperatures, particularly up-country. This lasted till after the end of the month.

Day temperatures were generally below average, and night temperatures above. The humidity during the day was above normal, that at night, on the whole about normal. Cloud was generally above normal. Barometric pressures were a little in excess, while wind strength on the whole showed no marked deviations from average. Wind directions were generally NE or NNE.

H. JAMESON,
Supdt., Observatory.